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for the drilling-producing-pipe line industry

PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

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PRICE OF OIL

WITHIN RECENT DAYS there has been considerable talk of a crude oil price increase. Whether or not it will come is something else. Possibly there is a 50-50 chance that it will.

We do not believe that the heavy buyers of crude oil want to see a price increase, because they are fearful of the effect of further advances at this time. But it is true that this same situation prevailed before and shortly after the last price increase and that the heavy buyers fell into line rather than lose connections.

A study of the financial statements of 30 leading oil companies shows that their profits for the first quarter of 1948 were nearly 100 percent above that of the first quarter of 1947.

The position of those companies who are regarded as sellers, rather than purchasers of crude oil, was especially strong. There is no reason to think that the position of the smaller producer is not strong also.

During the war and some time thereafter, before the price of crude was advanced, the producer was in a most unenviable position, but that situation has been changed.

Of course the producer knows, as does any one else who will study the situation, that he is selling oil developed with low cost drilling, and that if he stays in business he must replace it with oil which will cost a great deal more to find and produce, but somewhere there must be a point of safety—safety in staying in business from a political as well as a financial standpoint.

But such considerations do not always control. The shortage of a given refining company may cause it to push up the price of oil in the hope that it will be able to secure an adequate supply without too much disturbance of the market. The fact that such an action usually results in a general price increase is too easily forgotten—and when there is a general price increase the said refiner finds himself right back in the old groove.

As we have said many times, this publication's prosperity is directly dependent upon the prosperity of the producing and pipe line branches of the oil industry, so if a price increase would be a good and a sound thing for the industry it would be good and sound for us—but, we must keep in mind the long range prospects—the soundness of the general situation, and from that viewpoint, in which we surely must be in accord with our industry, we feel that further price increases at this time would likely cost more than they would produce.

The last price increase was followed by governmental investigations and a general repercussion which was not healthy. If a further price increase should coincide with the inability of the industry to deliver all of the petroleum products for which there will be a demand during the next nine months, then not only the marketer but the producer would be placed in a most unenviable position.

AN INVITATION

ELSEWHERE IN this issue of WORLD OIL, information is presented on the library of WORLD OIL, and an invitation is extended to the oil public to make use of its facilities.

Naturally everyone on WORLD OIL staff is proud of the library facilities which all of us have had a part in building up over a period of many years and which we are still improving. It has been the privilege of many of us to visit the libraries of other business papers and thus far we have not seen its equal. But lest we be accused of immodesty we hasten to add that we fully realize that the facilities referred to on other pages of this issue are not perfect or even close to perfect. Nor are we, as a staff, satisfied with them.

Daily our library is having an increasing number of visitors from the Houston area with a sprinkling of men from other areas. They are all welcome. You will be, too.

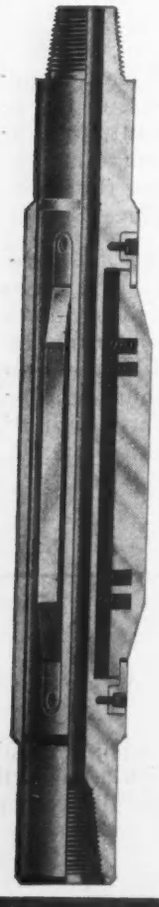
Ray L. Dudley

CLEAN UP THE "WORKING SURFACE" OF YOUR CASING

Read these facts about the Baker Rotary Casing Scraper

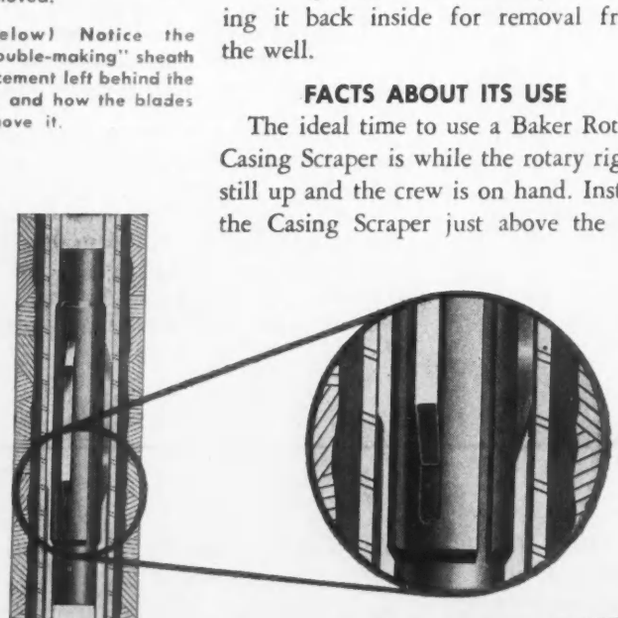
Have you ever tried to run testing tools or a swab, and had the rubber packing unit or the rubber cups so badly cut, torn and mutilated that the run was a failure? The chances are that trouble was caused by burrs from gunshot holes or by the sheath of hardened cement or mud which remains on the inside walls of casing, even after a bit of maximum possible gauge has been used to drill out after a cement job.

Until quite recently there was no fast, simple method of overcoming these difficulties. Now, however, it is truly a waste of time, temper and money to leave any obstructions adhering to or protruding from the "working surface" of your casing. The Baker Rotary Casing Scraper quickly, positively and economically removes *all* obstructions from the inside walls of casing, leaving the surface clean and smooth—ready for *immediate* testing and completion—and in good condition for any remedial or work-over operations *one year or ten years in the future.*



(Left) With only four springs back of each blade, burrs from gunshot holes are readily removed.

(Below) Notice the "trouble-making" sheath of cement left behind the bit, and how the blades remove it.



BAKER MODEL "B" ROTARY CASING SCRAPER
Product No. 620-B

STRONG, SIMPLE CONSTRUCTION

The Baker Rotary Casing Scraper consists of a strong body in which three long, reamer-type, hard-faced blades are vertically mounted. These three blades form an expansible reamer due to the fact that they are pressed outward against the inside walls of the casing by a number of coil springs. This self-equalizing feature insures constant, uniform contact with the walls of the casing, and is one of the secrets of the clean, smooth scraping action. Hard facing is applied in a flat, rectangular recess to form the long cutting edge of each blade, and a worthwhile amount of scraping can be done before the blades are dulled.

Ample circulating areas permit free disposal of cuttings; the streamlined exterior of the body insures ease in running-in; and if by accident the Casing Scraper is run out of the lower end of the casing, there is no difficulty in bringing it back inside for removal from the well.

FACTS ABOUT ITS USE

The ideal time to use a Baker Rotary Casing Scraper is while the rotary rig is still up and the crew is on hand. Install the Casing Scraper just above the bit when going in to drill out the cement shoe. Even when a bit of the maximum possible gauge is used for drilling-out, a thin, hard sheath (or skin) of cement will still remain adhering to the inside walls of the casing. The Baker Rotary Casing Scraper removes not only this hardened sheath of cement, but also scrapes away all mill scale, and smooths out rough areas. The inside of the casing is left clean and smooth, ready for trouble-free, down-hole work immediately thereafter, or at any future time.

If the well is gun perforated, then a second run of the Baker Rotary Casing Scraper will remove any burrs left around the gun-shot holes. The slight additional cost of this second run is negligible when you consider what the clean, smooth casing will mean when any future down-hole work is done.

If at a later time, after the rotary has been removed, obstructions on the inside walls of the casing interfere with operations, the Baker Rotary Casing Scraper still can be employed successfully. By running the Casing Scraper on tubing, and rotating manually with tongs, limited areas may be scraped; while several hundred feet of casing have been scraped by rotation of the tubing with an endless spinning rope, or by means of air tongs.

IT'S EASY TO HAVE THE "WORKING SURFACE" OF YOUR CASING IN PERFECT CONDITION

Baker Rotary Casing Scrapers are furnished on a low-cost rental basis in domestic fields, and *your* crews can run them easily and successfully to scrape the "working surface" of the casing before running casing, tubing, liners, swabs, testing tools, cement retainers, packers or other similar tools. It pays off in savings of time, temper and money.—Why not call the nearest Baker service engineer and start enjoying these benefits in *your* wells?

BAKER OIL TOOLS, INC. LOS ANGELES • HOUSTON • NEW YORK

The Changing Panorama

Inflation Victim: A Good Day's Work

LIKE A MAN on a drunk, the giddy U. S. economy took another swig out of the bottle of inflation last month.

The bull market was roaring. Prospects looked good for continued high prices and steady profits. A new epidemic of strikes was unlikely as employers yielded to wage requests. There was no drop in demand. Buying power was unchecked.

Under this whoop-em-up pressure, prices were forced skyward along a broadening front. Even General Electric, which had vowed to hold the line on the tried-and-true principle that for every binge there must be a hangover, was compelled to give up and dish out a pay hike.

As thinking men in all industries viewed the sad situation, they had reason to be concerned by more than an impotent dollar. Hardly less perturbing is the cheapened man-hour of work. Both the quality and quantity of the average employe's work is sub-normal by prewar standards. And the disparity between the purchasing power of the hard money of '39 and the gamboling greenback of today doesn't entirely account for it. If prices are up, then so, too, are wages, and the incentives of grocery bills, rent, and shoes for the children are no less urgent than before the war.

Why, then, does it grow increasingly difficult to purchase an honest day's work?

The answer lies outside the realm of the statistician. It will also elude the executive who attempts to gauge his employes' temper with a chart. The answer is nearer the grasp of a foreman whom we recently challenged with the problem. "The trouble is," said he, "nobody gives a damn anymore. Time after time I hire men that I know to be good men. I give them bonuses, pay them over the scale, and what happens? They work a couple of months and then blow—maybe to another town, another job, or maybe they'll just sit on their rear ends till their money's gone.

"Sometimes I think it's restlessness caused by the war. Sometimes I think it's just a case of too many jobs. Maybe security isn't enough to hold a man to his job. Maybe he's got to be about half-scared he'll starve to death unless he keeps turning out good work and lots of it. But whatever the reason behind it, I'm convinced of this: 'People just plain don't give a damn anymore.' "

Regulations Preventing Full Use of Natural Gas

NATURAL GAS could be making a much greater contribution to the energy supply of the United States if it were not for government regulations that discourage operations in all phases of the industry. Elimination of these restrictions is necessary to promote the maximum utilization of natural gas. These points were made by James E. Pew, manager of Sun Oil Company's natural gas and natural gasoline division, in the company's magazine "Our Sun."

Natural gas is needed to fill the gaps caused by rapidly climbing demands on the nation's overall enegry supply, asserted Pew, who was director of the natural gas and natural gasoline division of the Petroleum Administration for War during World War II.

Unsettled world conditions accent the need for greater utilization of America's natural gas reserves, said Pew. "Putting these vast natural gas surpluses to use would realistically bulwark our fuel resources and safeguard against any possible failure in energy supply. In the face of present world conditions," he continued, "self-sufficiency in the production of energy becomes a paramount consideration. Yet, as a nation, we seem as uncertain about a realistic policy on natural gas, which is here today, as we are on atomic energy for industrial power, which is a decade or more in the future."

Pew described present natural gas reserves as "surpassing today's record-breaking crude oil reserves on an equivalent heat basis." Yet natural gas today is supplying only 13 percent of the nation's energy needs. Largely responsible for this paradoxical situation, Pew explained, is a "forbidding, complex web" of municipal, state, and federal regulations.

Urging a realistic development of natural gas reserves to meet the public need, Pew attacked the philosophy that natural gas should be saved for so-called "superior" uses, such as domestic cooking and the manufacture of chemicals. He declared that restrictive regulation to hold down natural gas prices paid by domestic users, who consume only about one-eighth of all natural gas marketed, has resulted in the "diversion of to much of these resources into aimless bonfires."

Pew called for a more favorable economic and political climate for natural gas. He urged legislative provision for interstate transportation of natural gas on a common carrier basis with a "willing buyer on one end and a willing seller at the other" and enactment of legislation which denies to the Federal Power Commission any authority whatsoever over the risk business of oil and gas production.

A Long Shadow Over Louisiana

AFTER YEARS of clean government Louisiana is in trouble again and the shadow of Longism darkens the Pelican State.

Earl Long, brother of the late Huey (Kingfish) Long and often his bitter opponent in the past, is following in the footsteps of the late Dictator in proposing heavy taxes against the oil and gas industry. Governor Long apparently is following the mistaken policy which the late Huey pursued during his first few months as governor and which aims to "soak the rich oil and gas producers."

With the exception of a few independents, the oil and gas men did not support Long during his recent campaign. Ergo, tax the dissidents, even if it ruins the industry.

Long's new tax program will increase the levy on gasoline 2 cents per gallon. Present retail prices range from 28 to 33 cents per gallon and if the new tax is passed Louisiana will have the unhappy distinction of having the highest gasoline tax in the country . . . a distinction which was carried by Oklahoma until the legislature of that state discarded the "honor."

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MONTHLY NEWS ANALYSIS

EXPOSITION EVERY FOUR YEARS FAVORED . . . INDUSTRY OUTLAY RISING
SUPPLY PLAN LIKELY TO PROMISE EQUAL DISTRIBUTION AT ALL LEVELS
PIPE LINE PRODUCTION UP . . . LOANS FOR MEXICAN DRILLING STUDIED

Equipment Suppliers Favor Oil Show Every Four Years

The Petroleum Equipment Suppliers' Association, at its annual meeting in Colorado Springs, June 8, unanimously adopted a resolution recommending to the International Petroleum Exposition at Tulsa that future expositions be held at four-year intervals. The resolution also expressed the opinion of the association that no petroleum expositions be held elsewhere than at Tulsa.

The International Petroleum Exposition has sent out a questionnaire to all the 595 exhibitors who participated in the 1948 Exposition, asking their preference as to exposition frequency.

While the resolution adopted by the Petroleum Equipment Suppliers' Association carried with it only the recommendation of PESA members that the International Petroleum Exposition should be held only once every four years, and while members of the association numbered only 38 percent of all exhibitors (probably accounting for a much greater percentage of space used), the odds appear to be that the Exposition will be held only once every four years.

Exhibitors other than those belonging to the Petroleum Equipment Suppliers' Association have expressed themselves in favor of a frequency of every four years, a letter from one large such exhibitor having been read at the PESA meeting. PESA will send out a letter to all exhibitors at the recent exposition, acquainting them with the resolution passed June 8.

In his talk before the PESA meeting at Colorado Springs, William B. Way, general manager of the IPE, said it was the disposition of the IPE board to cooperate as far as possible in meeting the wishes of exhibitors. But he pointed out that a frequency of once every four years means a very expensive operation. One speaker suggested that the exhibit space charges be raised very substantially and that a "retainer fee" of a certain percentage per year in off years be added to keep the buildings in shape and to help carry the skeleton of an organization.

It also appears probable that the president of the Petroleum Equipment Suppliers' Association will be added to the executive committee of the Exposition, a request for such a procedure having been made in a resolution which carried unanimously. Another speaker suggested that an advisory committee composed of exhibitors be appointed to work with the executive committee of the Exposition.

The question of extending the length of the Exposition to two weeks came up for discussion, as did the proposition of opening each day at 10 a.m. and closing at 6 p.m. No recommendations were made but it appeared that sentiment was in favor of operating the Exposition more days than was the case during the recent show, thus permitting more oil men to attend.

There was considerable discussion on the question of limiting the attendance at the Exposition to oil men, but from what was said it did not appear that even the exhibitors were in favor of a hard and fast rule which would completely eliminate non-oil visitors. Recognition was paid to the public relations angle of the Exposition, but one speaker (not a member of PESA) won considerable approval when he said that he felt the exhibitors should not be called upon to finance an oil industry public relations job in one city, that the exposition in reality was an equipment exposition, and that oil men attending the exposition could be better served by the exhibitors if there were not the interruptions incidental to the admission of the general public to the show. He suggested that if the Exposition lasted two weeks, the public be admitted on the Sundays involved.

Concern had been expressed in Tulsa that if the Exposition were operated only once every four years, some other city might start an Exposition, or the Oil World Exposition in Houston might be resumed, which would mean that the International Exposition would have stepped aside three years out of four to make room for some other exposition. Some of the largest exhibitors said they would not show anywhere than at the International Petroleum Exposition in Tulsa.

Incidentally, there seem to be no signs of a revival of the Houston show. A good many of the members of the executive committee of the Houston show feel that due to the housing and hotel situation in Houston, as well as the lack of adequate exposition grounds, Houston should not attempt to hold an exposition.

Preliminary to the meeting of PESA, WORLD OIL compiled the results of a large number of interviews held with exhibitors during the Exposition in Tulsa, and made it available in mimeograph form to the manufacturers meeting at Colorado Springs. The report appears in full on page 44 of this issue.

Industry's 1949-50 Outlay Will Likely Top $4 Billion

The U. S. was given new proof that the industry is doing everything possible to meet its responsibility of supplying needed oil.

This came with the release of the petroleum prices and profits report of the House Commerce Committee.

The committee found that it is the concensus of industry that "great need" for these funds "should and can be met only out of high earnings and that this need well justifies the current price level of petroleum."

In a questionnaire to major oil companies, the committee asked: "What expansion (in dollar totals) of your facilities do you contemplate over the next three years? To what extent do you expect to finance such expansion of your facilities out of earnings and to what extent from other sources?"

When compiled, the answers added up to an outlay for 1949-50 that will probably exceed the whopping $4 billion allocated for 1947-48.

Some of the replies: Humble Oil &

Refining Company—$133 million in 1948, including $24 million for exploratory and development wells, and expenditures in the next two years are expected to continue at about same rate.

The Atlantic Refining Company—About $28 million increase in net fixed assets planned during 1948 and probably at same rate in 1949 and 1950, provided steel and other materials are available.

Cities Service Company—No budgets projected over three-year period, but construction expenditures in 1947 were about $96 million and are budgeted for 1948 at $140 million.

Continental Oil Company—Expansion over next three years will require an estimated total of $150 million.

Gulf Oil Corporation and Gulf Refining Company—At least $500 million in next three years.

The Pure Oil Company—For 1948, capital expenditures are scheduled at $40 million, while the estimated rate for each of the next two years is $30 to $40 million.

Shell Oil Company—Estimated capital expenditures in 1948-49-50 for expansion and replacements total $351,800,000, of which $136,850,000 is for expansion.

Standard Oil Company of Indiana—Contemplated capital expenditures for 1948 will aggregate about $220 million, making a total of $600 million spent during 1946-47-48. No estimate was given on expenditures for the next two years.

Standard Oil Company of California—Ventured no estimate, but noted that 1947 expenditures for facilities, development of oil production and exploration approximated $148 million.

Standard Oil Company of Ohio—Forecast for expenditures in 1948-50 totals $112,470,000.

The Texas Company—$500 million in next three years.

Tide Water Associated Oil Company—1948 capital expenditures will total about $37 million. Outlays for same purpose in 1949-50 probably will be as large or larger for each of the two years.

Theory of Disintegration Is Well Disintegrated

No less solid were the answers received by the House Commerce Committee on another phase of its questionnaire. The committee asked the companies to comment on the following quotation from Eugene Rostow's book, "A National Policy for the Oil Industry":

"The essential economic power in the oil industry is integration, and particularly the ownership by the major companies of transportation facilities; its essential consequence is size. . . . The unit of optimum size technologically bears no relation to the size of the great companies . . . integration is not a means of achieving economies in production, nor does it result in such economies. It is the basic means of achieving and maintaining monopolistic control over price."

Socony-Vacuum Oil Company rolled up its sleeves and hit hard: "Are only the largest integrated companies to be disintegrated and are the others to be allowed to go on? Are all to be disintegrated, and if so, into how many pieces shall they be split? . . . If it is wrong for a major company, by reason of its relationship to smaller marketers, to own marketing facilities, then why is it right for the jobber, who bears a similar relation to the retailers, to own any retail facilities?"

The Atlantic Refining Company hammered the disintegration theory with some cool logic: "May we point out that there are 23 integrated companies—some of whom like Sun, are of recent origin; that the automobile industry has three big competitors, the steel industry a half dozen, and the large chain stores can be counted on the fingers of one hand; in a word, competition exists, always has existed, and only those companies became integrated which were successful, and the total of integrated companies in the oil industry is far greater than in any other large industry."

Other comments: Cities Service Company—". . . It is our opinion that integrated companies by bringing greater stability to the industry have facilitated investment of capital and provided continuance of employment; that by taking long-term risks necessary to elaborate research they have improved methods of finding and producing crude oil and have improved the quality of products; and that they have contributed greatly to the low cost of products and unexcelled service to customers."

The Ohio Oil Company—The quotation is a "jumble of errors and inconsistencies . . ."

Standard Oil Company (N. J.)—"Integration is both a means of achieving economies and it actually results in such economies. There is no monopolistic control over price in the petroleum industry. Prices are made by the action of many sellers and buyers."

Standard Oil Company of Indiana—"The author's lack of knowledge of the oil industry is evidenced throughout his book."

Shell Oil Company—"The history of this company, certainly, demonstrates that the construction and ownership of transportation facilities was not a design to achieve monopolistic powers and had no such result, but quite the opposite, was a normal and logical business development for the purposes of becoming and remaining competitive with other units in the industry in the marketing areas accessible to it, and of providing lower consumer prices through lower unit costs of transportation."

The author of the Gulf reply used perhaps the most stinging brushoff of them all—the old American horse laugh: "While we were reading Mr. Rostow's polemic and discovering, with some amazement, the manifold and grievous imperfections, wasteful methods, and other shortcomings of the oil industry and its deplorably inefficient and monopolistic state, we were reminded of the once popular doggerel:

"The lady bug has wings of gold,
The June bug wings of flame;
The bed bug has no wings at all,
But he gets there just the same."

Change in Wording of Supply Plan Likely After Protests

A promise of equitable distribution at "all levels" instead of at "consumer levels" appeared likely to be inserted in the industry's voluntary allocation program after a Washington hearing that brought heated protests from petroleum marketers.

Numerous objections were registered to other aspects of the plan, but only the objective of eliminating hardship situations at the consumer level inspired critics in any number.

The program as originally set up was drafted by a subcommittee of the 33-man Petroleum Industry Advisory Committee appointed by Secretary Krug under Public Law 395. The agreement, with the approval of the Department of Justice and Secretary Krug, will entitle the petroleum industry to immunities from the anti-trust laws for the purpose of industry cooperation to achieve the most equitable distribution of available petroleum products.

The points incorporated in the plan were as follows:

1. The plan will go into effect immediately upon formal approval by the Secretary of Interior and shall terminate February 28, 1949, or earlier, if so designated by the Secretary of Interior.

2. Cooperative activities among members of the petroleum industry and with state and local fuel coordinators for the prevention, elimination, and alleviation of hardship situations at the consumer level are authorized by this agreement.

3. Each member of the petroleum industry participating in the agreement should continue equitable distribution of available supplies among all customers after fulfilling essential requirements for the military, food production, and essential public health and safety services. Each supplier should inform his customers periodically, at least once every three months after the agreement goes

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into effect, of the formula he will employ in distribution of his products.

4. District committees shall be appointed by the National Petroleum Council to carry out the plan. Personnel of these committees and of such subcommittees as may be appointed shall be subject to approval by the Director of the Oil and Gas Division of the U. S. Department of the Interior.

5. Minutes of meetings of committees and subcommittees shall be kept and a copy provided to said director. Meetings shall be open to accredited representatives of the Federal Government.

6. The National Petroleum Council and the committees and subcommittees appointed by it are authorized to assemble data and make studies relating to the supply and demand of petroleum, such as they deem advisable, and furnish all such data to the Director of the Oil and Gas Division.

7. Each district committee and subcommittee is authorized to make recommendations for voluntary action to adjust refinery yields and to more effectively distribute petroleum products.

8. The National Petroleum Council, its committees, and subcommittees are authorized to obtain facilities and personnel necessary for their activities and to finance such activities by voluntary contributions on such basis as they may determine.

9. All previous efforts to promote consumer conservation by members of the petroleum industry participating in this plan may be continued.

10. This plan does not apply to the exportation of petroleum or petroleum products.

11. No fixing of prices of petroleum or petroleum products is authorized under this plan or shall it be construed to permit any activities beyond the scope and purposes of Public Law 395.

12. The district committees and subcommittees are authorized to cooperate with state and local fuel coordinators and similar groups and to encourage the adoption by them of uniform practices to aid in furthering the objectives of this plan.

Tidelands Measure Left Unfinished by Congress

The tidelands measure was among the oil-important legislation which failed to clear Congress before its adjournment.

Safely past the House, the bill was not introduced to the Senate because of pressure for adjournment.

Other measures of interest to the industry which were left on the stack of unfinished business: The National Science Foundation bill, synthetic liquid fuels, small business tax exemption, Heselton control bill, natural gas act revisions and social security legislation.

Production of Line Pipe Up, But Continued Shortage Due

Line pipe will continue to be critically short for quite some time to come, despite sharply stepped up production. However, greatly expanded production of oil country tubular goods is giving the oil industry the steel necessary to drill the record-breaking number of tests being completed this year and will continue to supply the industry with most of the casing, drill pipe, and tubing wanted.

These conclusions are drawn from a welter of conflicting views presented before the House Interstate and Foreign Commerce Committee (Chairman Wolverton) and the Senate Small Business Committee (Chairman Wherry).

A pessimistic picture of the line pipe situation was painted by W. F. McConnor, vice president of National Tube Company, before the Wolverton committee. He estimated total 1948 line pipe production at 1,725,000 tons as against the National Petroleum Council's estimated need for 3,800,000 tons. Although line pipe production is much greater than the 617,000 tons made per year between 1937-1940, and considerably more than the 1,475,000 tons manufactured in 1947, it is "obviously impossible," declared McConnor, "for the pipe industry to meet the greatly increased demands in time specified by the NPC."

Jay W. Owings, manager of the oil country tubular sales for Youngstown Sheet and Tube Company, told the Wolverton committee:

"The increased production of oil country tubular goods in 1947 over 1946 was 27.8 percent, whereas the increased footage was 11.6 percent. The comparison of 1948 anticipated over 1947 is 11.5 percent, whereas the anticipated increase in footage is 15.7 percent. A comparison of 1949 anticipated with 1948 anticipated production indicates an increase of 2.5 percent whereas the increased footage is 2.7 percent.

"It will thus be seen that the steel industry increased its production by approximately the same percentage as the increase in footage, and the same relative increase will obtain during the next year. On the assumption that this year will see no further reductions in steel production and that the first half of next year will be free of work stoppages, we may assume a production rate of 1,600,000 tons, and while the 1,677,210 tons requirement figure indicates a small percentage deficit, there is no doubt this deficit can be made up through uninterrupted operations." This would indicate that there will be enough oil country tubular goods to meet requirements during 1948 and 1949 unless tube mills are called on to furnish semi-finished steel for overseas shipments.

C. A. Hahan, negotiator for the Petroleum, Gas and Oil Section of the Office of Industry Cooperation, Department of Commerce, estimated a deficit of 144,860 tons between now and June, 1949. He based this on requirements of 1,536,000 tons for domestic use and 208,860 tons for foreign operations against a production of 1,600,000 tons.

Commenting on testimony offered by steel authorities, Russell Brown, general counsel for the Independent Petroleum Association of America and also chairman of NPC's steel committee, said:

"If the supply of tubular goods is made available to the American petroleum industry in the volume indicated by Mr. Owings, the industry can be counted upon to meet a demand of 6,250,000 barrels during 1948 and 6,550,000 barrels daily in 1949."

While figures make the outlook for drilling operations much more encouraging, it would appear that there is no chance of meeting the industry's needs for line pipe. The question that naturally arises is whether increased production can be transported to refining centers and consuming markets if pipe line requirements are not fully met.

Military Men Alarmed by Short Supply Situation

U. S. military men are scanning the short supply situation with increasing alarm.

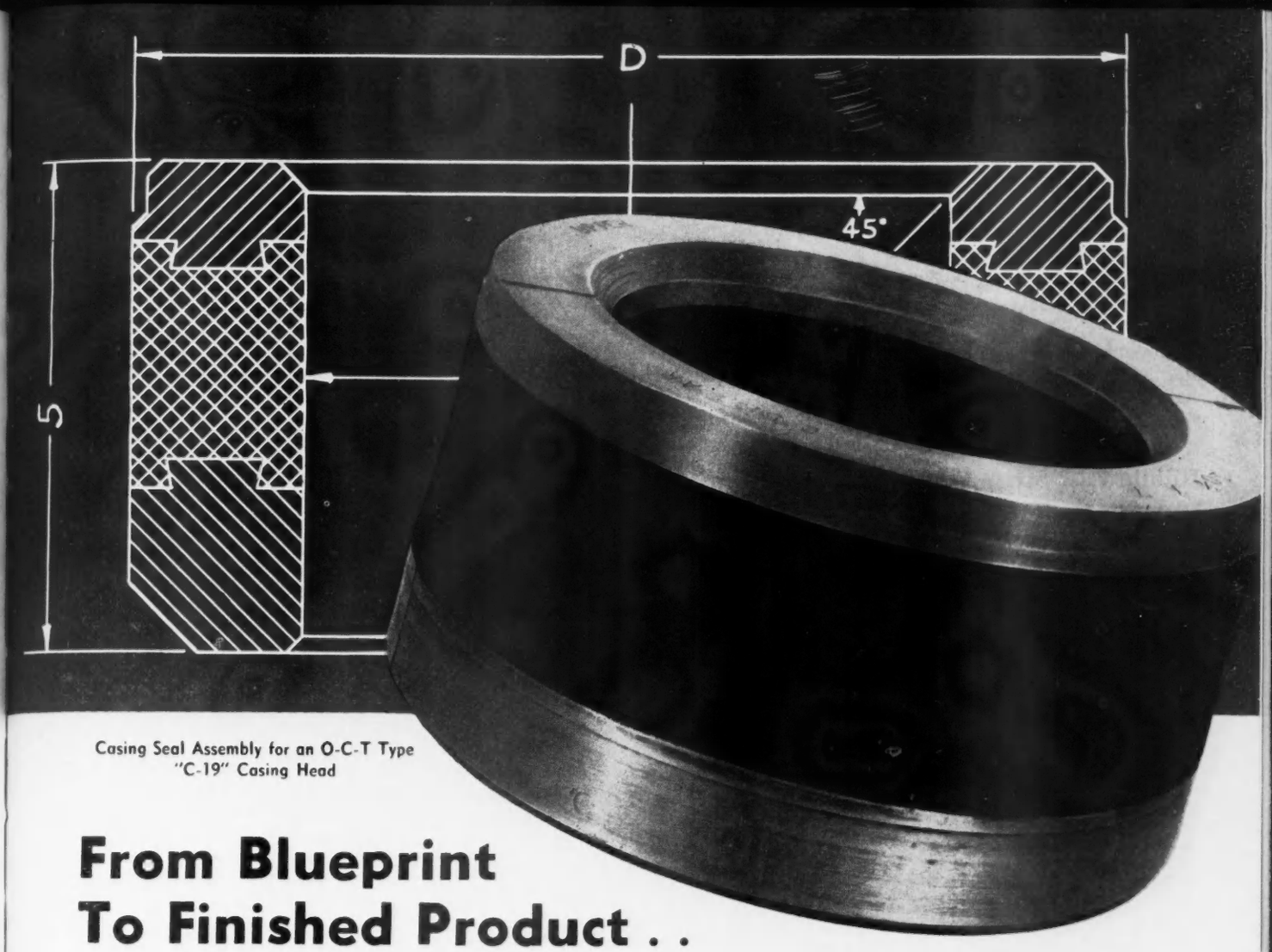
Their view: If the overburdened oil industry can stay only one jump ahead of demand at present, what will happen if the "cold" war suddenly becomes "hot?"

Capt. R. E. Wilson, deputy executive officer of the Armed Services Petroleum Board, answered this question last month at the 25th anniversary meeting of the Pennsylvania Grade Crude Oil Association. Said he: "The nation's shortage in reserve petroleum production capacity could conceivably become sufficiently serious to threaten our national existence."

The captain offered no new solution of the problem, but the urgency of his tone suggested that any one of several recommended plans would be acceptable, provided something is done speedily.

He mentioned continued maximum efficient production, increased imports, more steel for drilling, improvement of transportation facilities, unitization, continued research on primary and secondary recovery and refinery process, stockpiling, and greater use of industry advisory committees.

He reported that military lubricating oil requirements for the fiscal year beginning July 1 are estimated at 84 million gallons, which includes an estimated 29,400,000 gallons for Japan and occupied



Casing Seal Assembly for an O-C-T Type "C-19" Casing Head

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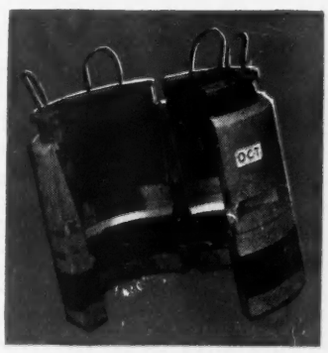

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Presented above is a typical case history of blue print to finished product. This casing seal assembly for the Type "C-19" Casing Head, manufactured by Oil Center Tool Company of Houston, Texas, was made entirely by Murray—steel insert and molded rubber.

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European areas, and combined Navy and Air Force requirements of 17,305,000 gallons.

He reminded that if military expansion progresses as indicated, the combined armed forces requirements for all products for fiscal 1950 should be considerably above those for 1949.

Military men were made a little happier when the House Senate Conference Committee last month agreed on a Senate-proposed appropriation of $9 million for further development and exploration of National Petroleum Reserve No. 1 (Elk Hills).

Middle East Strife Causes Long-Range Pipe Line Plans

Fighting between Arabs and Jews is cutting off Middle East oil from current use as well as future consumption, and at the same time is causing plans for additional outlets from the Middle East crude oil sources to move much farther into the future. While the unstable political situation persists, it has already caused virtual shelving of plans for two big lines from Saudi Arabia and Iran, stoppage of flow through the line from Kirkuk to Haifa, and although Iraq Petroleum Company plans yet another "big-inch" line to the Mediterranean, these considerations, plus shortage of steel has caused scheduling of the line for late 1951 instead of the immediate future. With only a few miles more to go, the new IPC 16-inch carrier which would have brought another 90,000 barrels daily from Kirkuk has been stopped at the Palestine border.

Crude shipments from the pipe line terminal at Haifa were practically stopped in early June and the Haifa refinery, with 90,000 barrels daily capacity, has been shut down since April 12. Arab refinery workers had been fired upon several times while moving to and from work, and refused to continue on the job after several had been killed.

The northern leg of the IPC system, terminating at Tripoli, has remained in operation, and although the new 30-31-inch line now proposed would follow this northern route and would make an additional 275,000 barrels available to Mediterranean shipping points, construction is not scheduled to begin for another three years since it is not thought that pipe would be available from the U. S. before then. It is planned for the work to be done by American contractors, with total cost estimated at $160 million.

With demand continually reaching new peaks, and producing capacity elsewhere in the world sorely taxed, little chance for relief from the Middle East is seen as long as internal strife blocks necessary outlets.

Gulf Coast Off-Shore Development Increasing

Off-shore drilling of wells along the Louisiana-Texas Gulf Coast is assuming important proportions. Recent weeks have brought announcement of a considerable number of new well locations by various companies. This development is encouraged by the placing on production of the discovery well of Kerr-McGee Industries, Inc. The well is about 12 miles from the nearest land, along the Louisiana coast, in ocean water about 18 feet deep.

Approximately 30 companies, mostly larger concerns, are now active in Continental Shelf geophysical or drilling development.

Much has been learned already about drilling on the ocean sites, several different methods having been employed by various companies. And something is being learned about the handling of production from an off-shore field, while plans have been made for laying a pipe line from the Kerr-McGee producing well to a location on land.

In these operations are witnessed today the beginnings of a Continental Shelf petroleum development that probably will eventually assume great importance and size.

It has been estimated that the same productivity for the Continental Shelf as for the adjacent land belt of the Louisiana-Texas Gulf Coast would afford reserves of nearly 6 billion barrels off Louisiana and Texas within water depth of 150 feet, the estimated limit for off shore drilling with present methods.

The current status of Continental, Shelf development along the Gulf Coast is shown in a special article in this issue. (See page 37.)

Senate Committee Studies Loans for Mexican Drilling

With the object of making it possible for independent U. S. operators to become oil producers in Mexico, the U. S. Senate small business committee has been working on contemplated legislation affecting such development. The committee proposes to authorize the Reconstruction Finance Corporation to make loans to the American independents, accepting as security the bonds of Petroleos Mexicanos, Mexican government oil monopoly.

The committee has held several public hearings on this subject. In them there was testimony by U. S. operators that they had negotiated with the Mexican government, which had offered them "Pemex" bonds as part payment for drilling and development work to be done by the Americans.

The RFC was said by men on the Senate committee to have approved the legislation. The lending agency was reported to have expressed the view that bonds guaranteed by the Mexican government would be equally as safe as some securities on outstanding RFC loans.

Recently the committee was told by the State Department that it realized the desirability and importance of developing such close-to-home sources and that there would be no objection to issuance of letters by military or other federal agencies signifying intent to buy Mexican crude from American operators.

In contrast to the reception of some American companies, the State Department seems favorably disposed toward the contract terms recently made public by Petroleos Mexicanos.

California to Restrict Off-Shore Seismic Work

Off-shore seismic exploration work again is under fire, this time in California waters and from the California Division of Fish and Game. In an order recently released, the Division announced that any oil company contemplating seismic exploration work off the California coast during the next two years must file an application for a permit between June 15 and July 15, 1948. No permits well be granted for off-shore exploratory work within the 24-month period except to those companies which have so applied. When all applications are on file, a meeting will be held with the applicants and allocation of permits will be discussed.

Doubtless this order will mean curtailment of activities by the six or more companies presently conducting off-shore exploration work, as well as by those companies, not now interested, who might become interested at a later date. It is the announced intention of the Division to bring to a halt the practice of one company going into an area to do the same work that a previous company has just completed, with extensive damage being done to fish life by the continued heavy shooting. Residents of coastal communities also have protested the annoyance of heavy blasts in the shore areas. The Division has expressed the hope that wherever possible, oil companies will be able to join forces and conduct joint operations in a given area instead of each carrying on the same type of work, one after the other.

Exploration in one area, lying between Point Fermin, near San Pedro, and Newport for some time has been limited to only two months out of the year, March and April, to reduce to a minimum the "very serious" damage to fish life. After October 1, 1948, no company will be permitted to explore an area along the California coast within one year of a previous survey.

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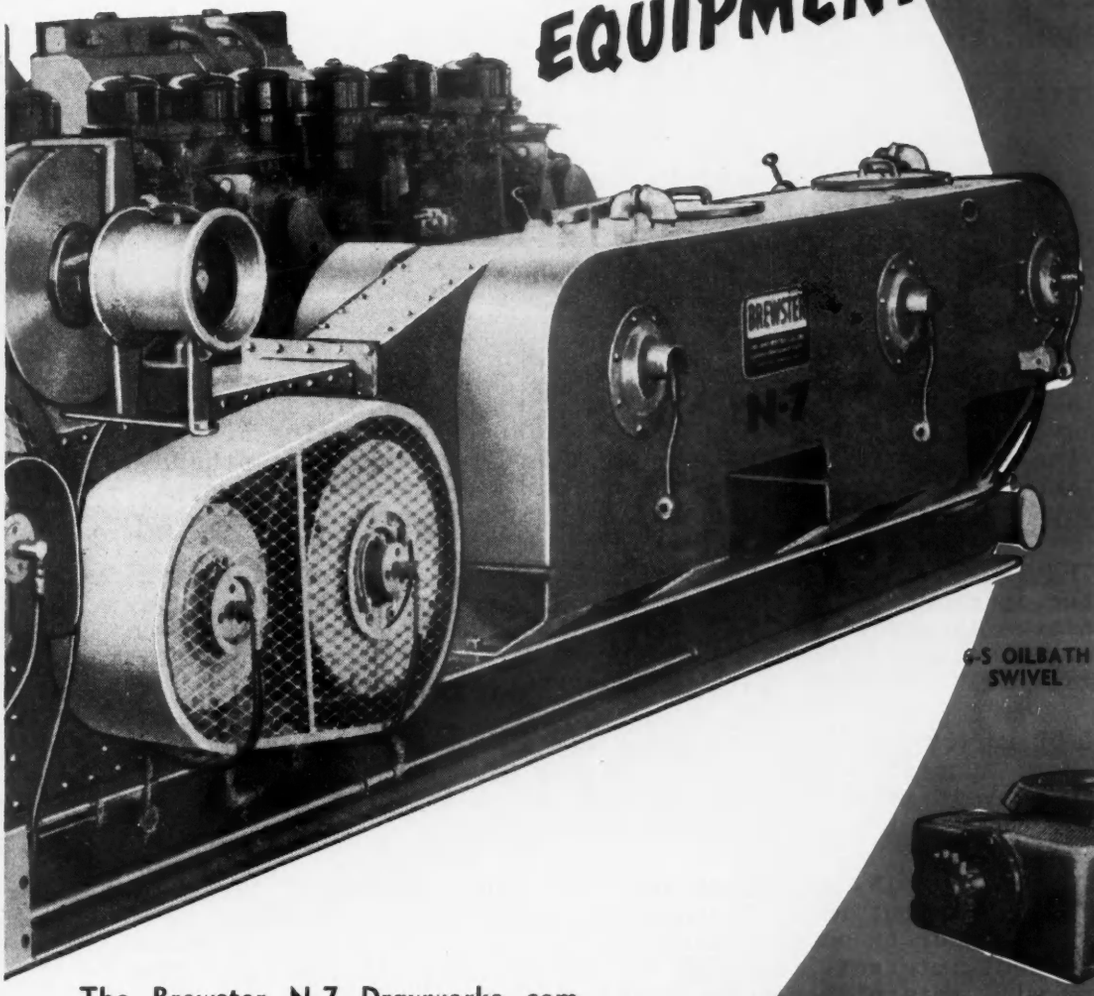
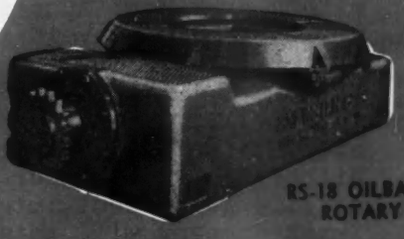
WITH MATCHED EQUIPMENT



200 TON BLOCK

6-S OILBATH SWIVEL



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Looking Ahead

● PETROLEUM INDUSTRY prices likely will increase in near future, in publicly expressed opinion of several major company spokesmen. Familiar harbinger of higher prices is seen in payments of premiums for crude oil by some refiners. Exerting upward pressure on prices are such forces as tight supply of crude, unchecked rise in costs of building materials, and the new increases in wages of workers in general as well as oil industry workers.

● GOVERNMENT RATIONING of gasoline this summer now appears very unlikely. Threat of rationing was largely dispersed by Secretary of Interior Julius A. Krug. He advised White House that no serious petroleum shortage was indicated, although there might be local and temporary scarcities. Imposition of government controls might make matters worse instead of better, he stated.

● ARAB-ISRAEL WAR is disrupting and restricting present and future world utilization of Middle East petroleum. Substantial supply already is interrupted through war-caused shutdown of Haifa refinery and idling of pipe lines supplying it. Much greater future supplies for Europe and other consuming areas are being forestalled or delayed by war-caused stoppage of work on pipe lines from Middle East fields to Mediterranean.

● OIL INDUSTRY is well along toward making petroleum supply fully equal demand, in the opinion of a major company executive. Generally adequate supply henceforth is predicted, despite possibility that there may be an occasional dry gasoline station this summer and a few homes that will not get all heating oil they want just when they want it next winter.

● SOME BUILD UP in working stocks of petroleum products is being attempted, with a degree of success. Increased stocks are sought because they would greatly help to avoid repetition of transportation troubles encountered last year.

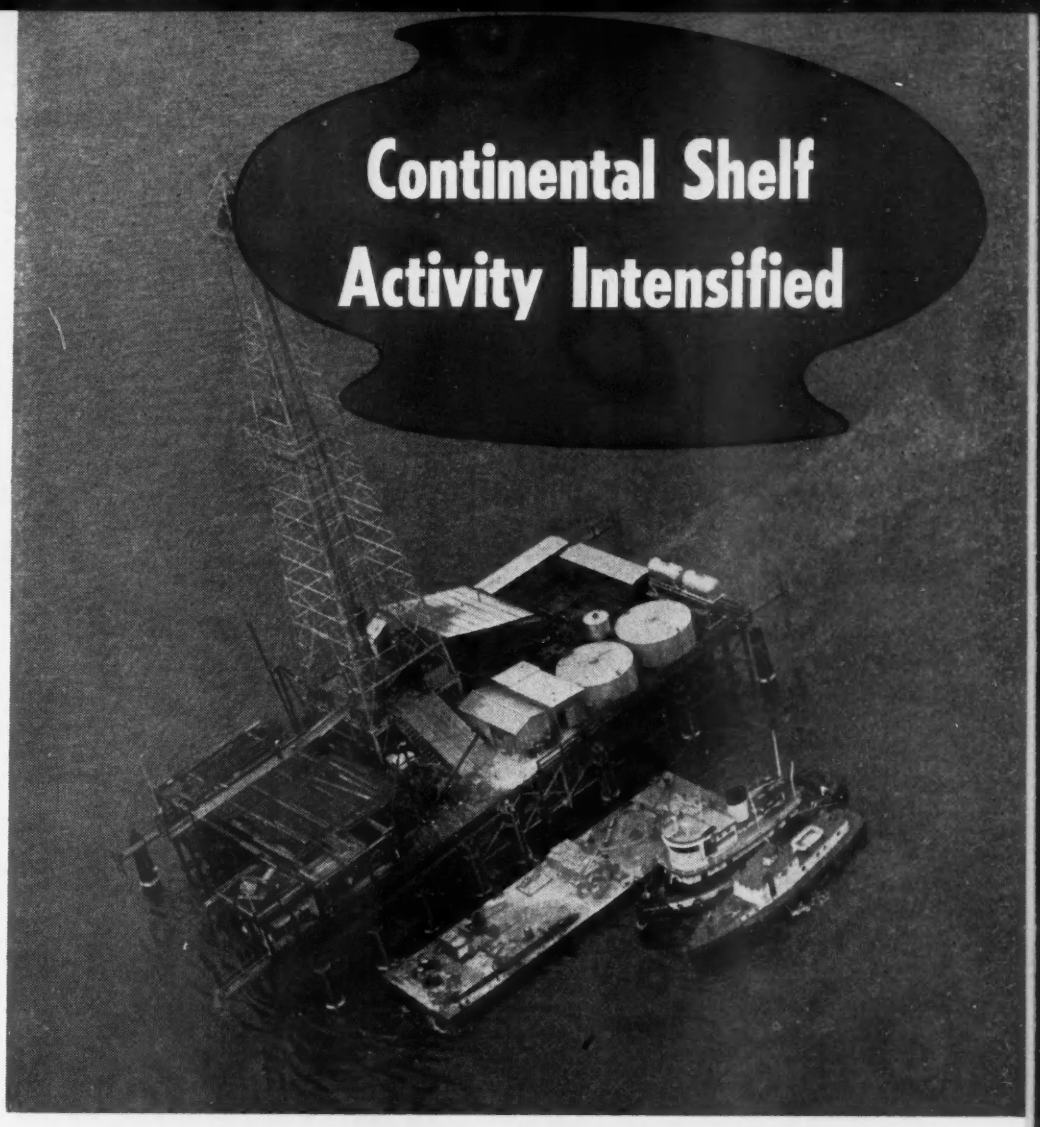
● STANDARD OIL COMPANY (N. J.) hopes for early consummation of its acquisition of 30 percent interest in Arabian-American Oil Company, either by agreement or by court action. Socony-Vacuum Oil Company will acquire 10 percent interest. Standard Oil Company of California and The Texas Company will retain 30 percent interest each.

● AUTOMOBILE GASOLINE consumption may be substantially reduced within a few years. Spurred on by high original and operating costs of cars today, automobile manufacturers are seeking ways of reducing these expenses. Many manufacturers are planning more economical automobile engines. Some designers predict gasoline consumption of cars will be reduced by as much as one-third within a few years.

● LOOK FOR increasing emphasis to be placed on safety programs among drilling contractors. By adhering to such programs, contractors in some recent instances have had their insurance rates reduced by as much as $6 per hundred, in addition to the lowered incidence of injuries to personnel and accidents. To the moderate size drilling company, such savings easily could amount to several thousand dollars per year in insurance premium savings alone.

Continental Shelf Activity Intensified

EIGHT LARGE companies are climaxing months of preliminary work with extensive exploratory activities on the Gulf Coast Continental Shelf, which some authorities estimate will yield upwards of 6 billion barrels of crude. Extending about 30 miles seaward and dotted with salt domes comparable to those in the rich fields of Texas and Louisiana, this area may contain some of the world's most prolific oil deposits.



Among the first outstanding projects to extend far out into the Gulf was Magnolia Petroleum Company's State Lease Gulf Block 58 Well No. 1, located ten miles south of Point Au Fer off the Coast of St. Mary Parish. The drilling platform, costing hundreds of thousands of dollars, was composed of both steel and treated wooden piling erected in 18 feet of water. The well was drilled to a total depth of 12,615 feet and later sidetracked without encountering appreciable amounts of oil.

By
L. J. LOGAN & CECIL SMITH
Staff Writers

THE past several years have brought intensification of development of the oil possibilities of the continental shelf along the Gulf Coast, and activity is now at the highest level so far reached. There is production from the discovery well of a field 12 miles off the Louisiana coast in 18 feet of open Gulf water. More than a score of other offshore locations have been made and now show up on the map as completed, drilling, or scheduled to be drilled. Various companies have participated in actual drilling and others are contemplating drilling. Numerous companies are carrying on geophysical and other preliminary exploration work. Activity has centered mainly off the Louisiana coast, but substantial drilling off the Texas coast is contemplated.

Eventually, the continental shelf off Mississippi, Alabama, and the western side of Florida probably will be explored. But it may be assumed that early work will continue to be centered mainly off the Louisiana and Texas shores, since those areas are adjacent to established rich fields on land.

At the beginning of June there were 13 locations in the open Gulf waters where operations were well under way. Seven of these were the scenes of actual drilling, while drilling platforms were being erected on the other six. In addition to these, ten more new locations had been announced. All of these were Louisiana operations with the exception of three locations being staked off the Texas coast.

Magnolia Is Leader

Magnolia Petroleum Company is the leading operator in this continental shelf work. It has completed two dry wells, and is now drilling three more tests, one at the testing stage. This company is also building a drilling structure on one location and has announced that two others will be drilled. Humble Oil & Refining Company, a more recent entry in this activity, has one well testing, building platforms at three other sites and has announced four other locations, one of which will be off the Texas coast.

Kerr-McGee Oil Industries, Inc., owner of the only oil producer outside the 3-mile limit, has two wells drilling. One of these is a wildcat that was spudded at about the same time as the discovery well of the Block 32 shallow salt dome field, and a second well in the new discovery area. Three locations have been announced by Stanolind Oil & Gas Company, two off Louisiana and one off Texas coast. However, no actual work has started at these locations and the company is now engaged in assembling a fleet of working boats. All of the above operations are being done with company tools.

The Pure Oil Company is building a platform off the Vermilion Parish shore for a 12,000-foot wildcat which has been contracted to Loffland Brothers. Also off Louisiana is a well being drilled by The California Company and a platform is being readied at another site by the same company. Noble Drilling Company is doing this work for California. The

only other Gulf of Mexico location is one recently made public by The Ohio Oil Company, which will drill jointly with Melben Oil Company off the Texas coast southeast of Freeport.

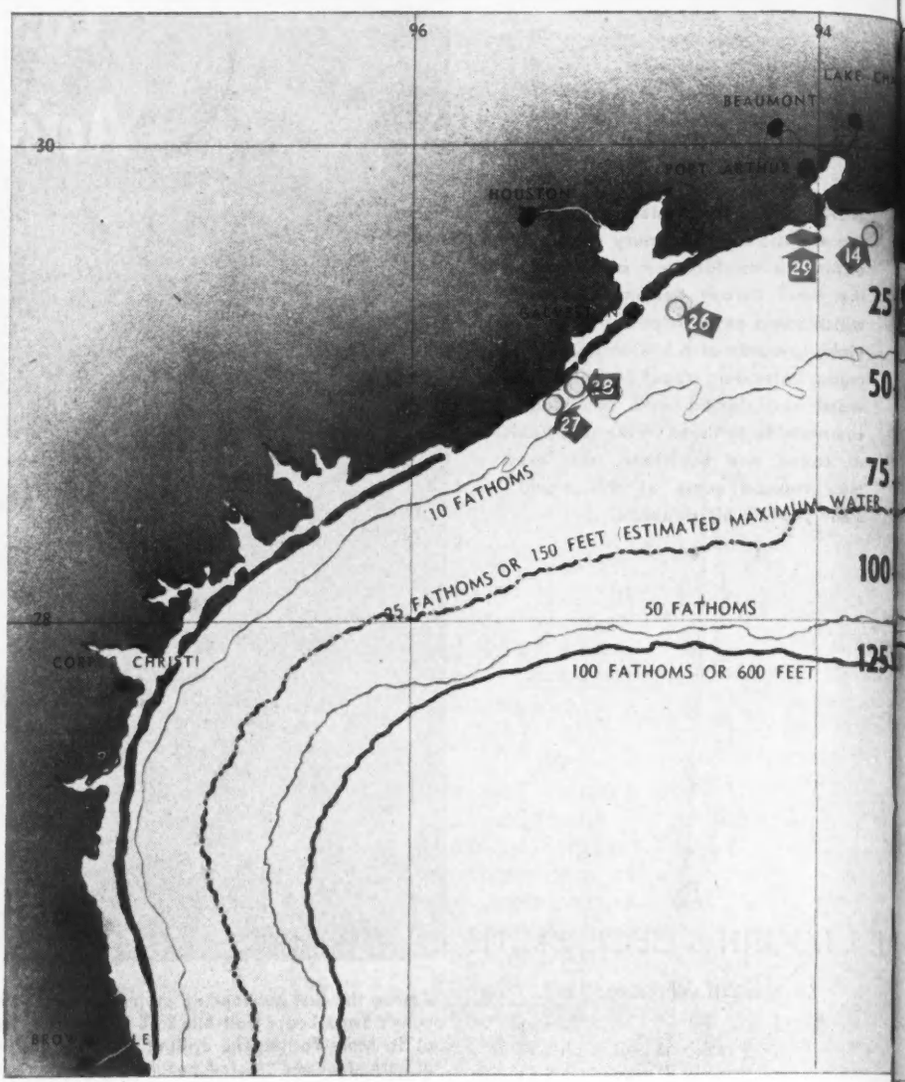
Information showing how offshore development has been accelerated and expanded was cited by Dean A. McGee of Kerr-McGee Oil Industries, Inc., in a paper delivered at the International Petroleum Congress at Tulsa, May 19, 1948.

"A continental shelf is the sea floor beneath the belt of marginal shallow waters which surround a continent," stated McGee. "The usual definition limits the shelf to a water depth not exceeding 100 fathoms or 600 feet. It is the seaward portion of a great shelving plain which intervenes in the region of the margins of the continents between the continental high areas and the oceanic depths. There has been exploration, and oil now being produced in fields a short distance off the coast of California and in a number of fields in the bayous, bays, and marsh lands of the Texas and Louisiana Gulf Coasts. However, there had been no intensive, concerted, and systematic effort to explore the continental shelves of the U. S. until the present campaign off the Louisiana Gulf Coast started about four years ago.

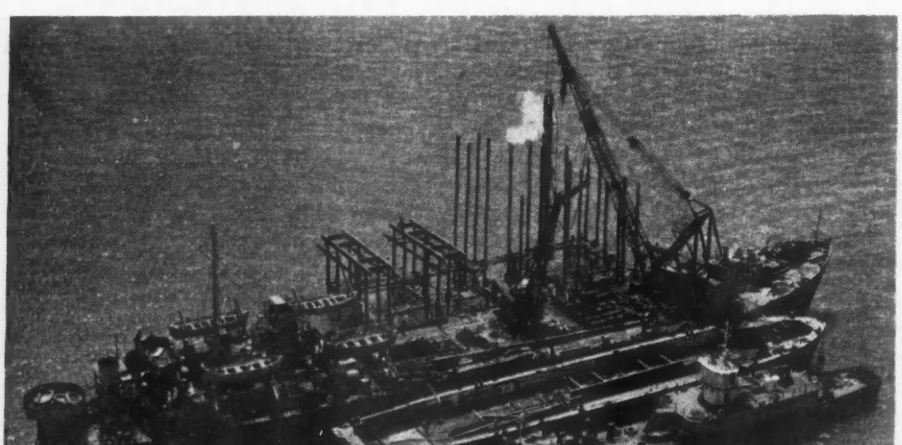
Huge Deposits Indicated

". . . There are several factors that indicate that the continental shelf areas of the world and especially those off the Texas and Louisiana coasts may prove to be the most prolific oil-bearing provinces on earth. One of the most important of these is that the shelf region in the Gulf Coast coincides with one of the most extensive developments of sedimentary beds of recent geologic age—beds which have yielded the greater part of the petroleum so far discovered.

Wells Drilling, Projected and Completed

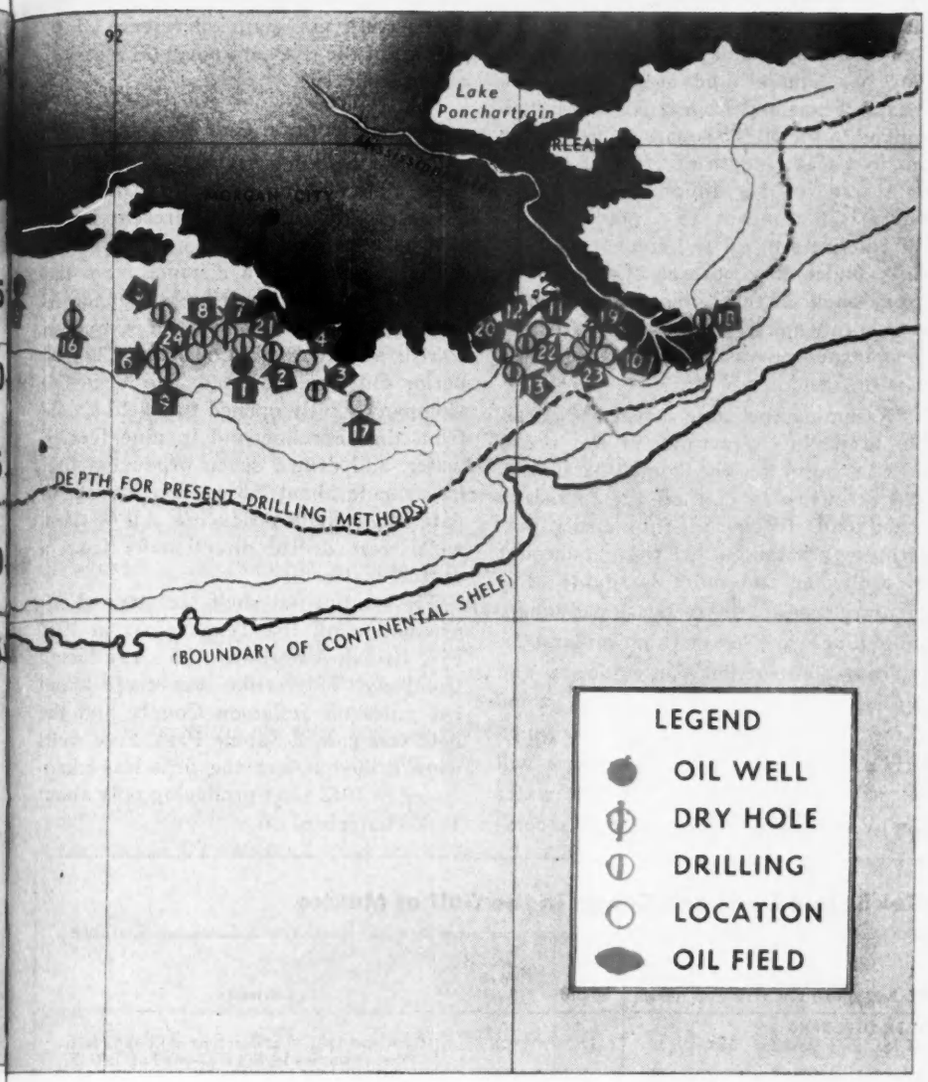


". . . The area of the continental shelf within the Gulf of Mexico," continued McGee, "is approximately 200,000 square miles. Of this total area approximately 51,000 square miles lie off the coasts of Texas and Louisiana. There has been some geophysical exploration of the continental shelf area off the west coast of Florida and there is, at this time, reported to be approximately 6 million acres of coastal waters under oil and gas lease. In the past the coastal waters of Alabama and Mississippi have been explored geophysically to a small extent. There is now no active exploration campaign in progress off either the Alabama or Mississippi coasts. The Texas continental shelf area has in the past been explored geophysically to some extent, and there are oil and gas leases in force in the open waters of the Gulf off the coast. There is some geophysical exploration now in progress off the Texas coast and an intensive campaign is in prospect as soon as the state regulatory bodies have formulated rules and regulations which will permit the orderly



This drilling platform near Tigre Pass is one of several being constructed by Humble Oil & Refining Company off the coast of Louisiana.

the Continental Shelf of Louisiana and Texas



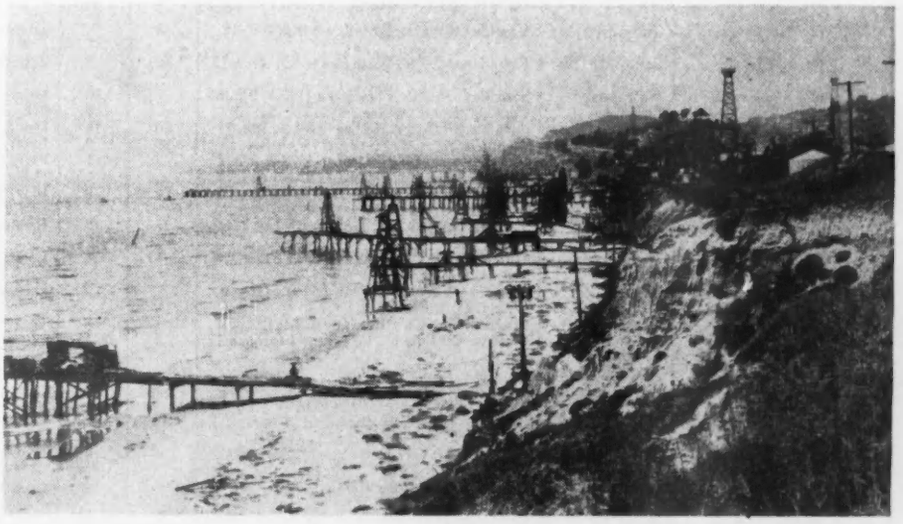
search of unleased areas. The continental shelf off the Louisiana coast has had by far the most intensive geophysical exploration, and as a result there are more oil and gas leases, more known prospects, and more wells that have been drilled, in the process of drilling, or proposed for drilling, than in any other part of the continental shelf of the Gulf of Mexico."

Salt Domes Present

In the past four years, said McGee, "seismic work off the Louisiana coast has demonstrated that salt domes of the same general type and character as those found on land extend out to a distance of at least 30 miles from the coast line. Exploration work is now being carried on at distances greater than 30 miles from the coast line. The U. S. Navy recently announced that work which it has been carrying on 75 miles from land in the Gulf of Mexico has indicated the presence of one or more salt domes. All the information available at this time tends to indicate that salt domes, and consequently structural conditions favorable for the accumulation of oil and gas, are present at great distances from the Louisiana and Texas coast lines and that the limiting factor in the development of these favorable prospects may be the industry's ability to devise methods and equipment for drilling wells in the relatively deep waters of the ocean where they occur."

Exploration Intensified

Seaward boundaries of Louisiana and Texas are 27 marine miles from shore, said McGee, and "the exploration of the Louisiana coastal belt out to a distance of 27 miles has been in progress to some extent for a number of years, but in the past two years the exploration has been greatly intensified. In January, 1948, at least 20 oil companies were aggressively engaged off the Louisiana coast alone. The exploration has, of course, all been geophysical, the seismograph and diving bell type of gravity meter being the principal methods used. In January, 1946, there were two seismograph and no gravity meter crews operating off the Louisiana coast. In January, 1947, there were 14 seismograph and four gravity meter crews, and in January, 1948, there were 28 reflection seismograph crews and two gravity meter units. In January, 1946, one of the seismograph units was of the refraction type, and in January, 1947, four were refraction units, while in January, 1948, all units were of the reflection type. The refraction seismograph and the diving bell type of gravity meter were favored for reconnaissance in the early phase of open water exploration. As equipment and techniques for reflection seismograph work on water have



Summerland field, California, discovered in 1892, was the first oil area opened on the continental shelf of the U. S.

been rapidly improved, the other two methods have been replaced."

Commenting on results of geophysical work, McGee said: "It is estimated that at least 36 salt dome prospects have been mapped and leased in the coastal waters of Louisiana. As would be expected, the salt dome prospects underlying the water-covered areas duplicate in type, character, and density of occurrence those found on the adjacent coastal land belt. There are both deep-seated and piercement-type domes. There are domes with large structural closure and with relatively small closure. The pattern of their occurrence is very similar to that on land."

Deep Water Possibilities

Offshore drilling has been undertaken so far in water ranging up to 50 feet in depth. "It is believed," said McGee, "that with the present methods and equipment it is practicable to drill wells in water depths up to 150 feet in the unprotected waters of the Gulf of Mexico. That area of the continental shelf lying off the Louisiana and Texas coasts covered by water to a depth of 150 feet is approximately 30,500 square miles.

"It may be of interest to speculate on the size of the potential oil reserve within this area. An approximation has been made of the number of barrels of oil and condensate that have been discovered to date per square mile of land area in coastal Texas and Louisiana. This figure applied to the 30,500 square miles of area out to a water depth of 150 feet results in a total of 5.8 billion barrels. This figure is not meant as a prediction of the resources of oil and condensate that exist under this portion of the continental shelf off the Louisiana and Texas coasts, but merely as a rough yardstick to indicate the vast proportions of this new oil frontier.

"Assuming the same density of possible producing structures in the ocean area as occur on the land coastal belt, and the work to date off the Louisiana coast tends to confirm the density pattern, the possibilities are that on account of a thicker and more favorable sedimentary section, the recovery per square mile of area will exceed that on land. In addition, as experience in exploring and drilling the water-covered areas is gained through the years, the distance to which drilling can be carried from shore will exceed substantially the 150-foot water depth arbitrarily selected for this comparison. Therefore, it seems logical to assume that in this new oil province we may have a minimum oil reserve of 25 percent of the present known oil reserves of this country."

Production in Gulf Not New

Oil production in the open waters of the Gulf had been established long before Kerr-McGee made its recent Block 32 field discovery, although this was the first found at such a distance from the shore. The first oil strike was made in 1938 in the Creole field, off Cameron Parish, southwestern Louisiana. The Superior Oil Company and The Pure Oil Company jointly opened this field a mile from the shoreline and in nine feet of water, and drilled seven producers that have made about 2.8 million barrels to date and are still producing. All of these wells were drilled directionally from a central platform.

The continental shelf was tapped for production off the Texas coast in 1941 by British-American Oil Producing Company. This strike was made about 1½ miles off Jefferson County and the field was named Sabine Pass. Five wells were drilled before the field was abandoned in 1942 after producing only about 10,000 barrels of oil.

Drilling Off the Texas and Louisiana Coasts in the Gulf of Mexico

Number on Map	County or Parish	Area	COMPANY, WELL AND LOCATION	Water Depth (Feet)	Miles from Shore	Status of Well (6-1-48)	Remarks
			SOUTH LOUISIANA				
1	Terrebonne	Ship Shoal	Kerr-McGee Oil Ind. Inc's State Lse 754-1, Blk. 32.	18	12	Oil well	Completed 11-17-47 as discoverer of Block 32 field. First production beyond the 3-mile limit in Gulf.
2	Terrebonne	Ship Shoal	Kerr-McGee Oil Ind. Inc's State Lse 750-1, Blk. 28.	12	7½	Drilling	In shale at 13,244 feet.
3	Terrebonne	Ship Shoal	Magnolia Pet. Co's State Lse 766-1, Blk. 72	....	10½	Testing	Topped salt at 8290-ft. Has tested gas and condensate.
4	Terrebonne	Ship Shoal	Stanolind O&G Co's State Lse 757-1, Blk 38.	9	6	Location	
5	Iberia	Eugene Island	Magnolia Pet. Co's State Lse 838-1, Blk. 45	20	12	Drilling	Hole lost at 12,615-ft when well kicked. Now sidetracked to 11,687-ft.
6	St. Mary	Eugene Island	Magnolia Pet. Co's State Lse 684-1, Blk. 54	21	25	Dry & Abnd.	In salt at 2613-ft which was topped at 2606-ft.
7	St. Mary	Eugene Island	Magnolia Pet. Co's State Lse 673-1, Blk. 58	16	6	Dry & Abnd.	T. D. 12,874-ft.
8	St. Mary	Eugene Island	Magnolia Pet. Co's State Lse 679-1, Blk. 77	....	14	Drilling	Kicked at 2,514-ft in salt. Circulating and awaiting heavy mud.
9	Iberia	Eugene Island	Magnolia Pet Co's State Lse 686-1, Blk. 110	....	27	Bldg. Struct.	
10	Plaquemines	Tiger Pass	Humble O&R Co's State Lse 818-1, Acct. I, Blk. 27.	....	6	Location	Scheduled to 14,000-ft.
11	Jefferson	Grand Isle	Humble O&R Co's State Lse 797-2, Acct. III, Blk. 9.	44	6½	Bldg. Struct.	Scheduled to 5,000-ft.
12	Jefferson	Grand Isle	Humble O&R Co's State Lse 801-1, Blk. 18	48	8½	Testing	Topped salt at 7607-ft. Slight shows of oil and gas on 2 tests.
13	Jefferson	Caminada Pass	Humble O&R Co's State Lse 803-2, Acct. II, Blk. 22.	30	9	Bldg. Struct.	Scheduled to 5000-ft.
14	Cameron	West Cameron	Stanolind O&G Co's State Lse 1133-1, Blk. 45	....	10	Location	Scheduled to 12,500-ft.
15	Vermilion	Vermilion	Pure Oil Co's State Lse 880-1, Blk 39	....	8	Bldg. Struct.	Scheduled to 12,000-ft.
16	Vermilion	Vermilion	Superior Oil Co's State Lse 884-1-A, Blk. 71	20	19	Dry & Abnd.	T. D. 13,628-ft. No shows.
17	Terrebonne	S. Lake Pelto	Magnolia Pet. Co's State Lse 791-1, Blk. 11	26	9	Location	Scheduled to 12,000-ft.
18	Plaquemines	North Pass	The California Co's State Lse 1278-1, Plk. 60	....	4	Bldg. Struct.	Scheduled to 12,500-ft.
19	Plaquemines	West Delta	The California Co's State Lse 816-1, Blk. 24	....	1¾	Drilling	Below 3,028-ft.
20	Jefferson	Caminada Pass	Humble O&R Co's State Lse 799-1, Acc. II, Blk. 16.	30	5	Bldg. Struct.	Scheduled to 14,000-ft.
21	Terrebonne	Ship Shoal	Kerr-McGee Oil Ind. Inc's State Lse 754-2, Blk. 32.	18	12	Drilling	Second well in the new Block 32 field.
22	Plaquemines	West Delta	Humble O&R Co's Pelican Island State Lse, Acct. I, Blk. 30.	....	8	Location	Scheduled to 5,000-ft.
23	Plaquemines	West Delta	Humble O&R Co's Pelican Island State Lse, Acct. II, 2, Blk. 31.	....	9	Location	Scheduled to 14,000-ft.
24	St. Mary	Eugene Island	Magnolia Pet. Co's State Lse 678-1, Blk. 76	....	16	Location	Scheduled to 10,000-ft.
25	Cameron	Creole field	Superior Oil-Pure Oil Co's State 1 through 12	9	1	.....	Discovered in 1938. Wells were drilled directionally from a center platform and producers now number 7.
			TEXAS GULF COAST				
26	Galveston	.....	Stanolind O&G Co's State-Gulf of Mexico 1, Blk. 144.	46	12	Location	South of Caplen field and Bolivar Peninsula.
27	Brazoria	E. Freeport	Humble O&R Co's East Freeport-State 278-1, Blk. 278.	....	6	Location	Scheduled to 12,000-ft.
28	Brazoria	E. Freeport	Ohio Oil Co-Melben Oil Co's State-Gulf of Mexico 1, Blk. 248.	....	6	Location	15 miles southeast of Freeport.
29	Jefferson	Sabine Pass field	British-American Oil Prod. Co 4 wells; Harwell Oil Co. 1 well.	....	1½	.....	Field discovered in 1941, and abandoned in 1942.

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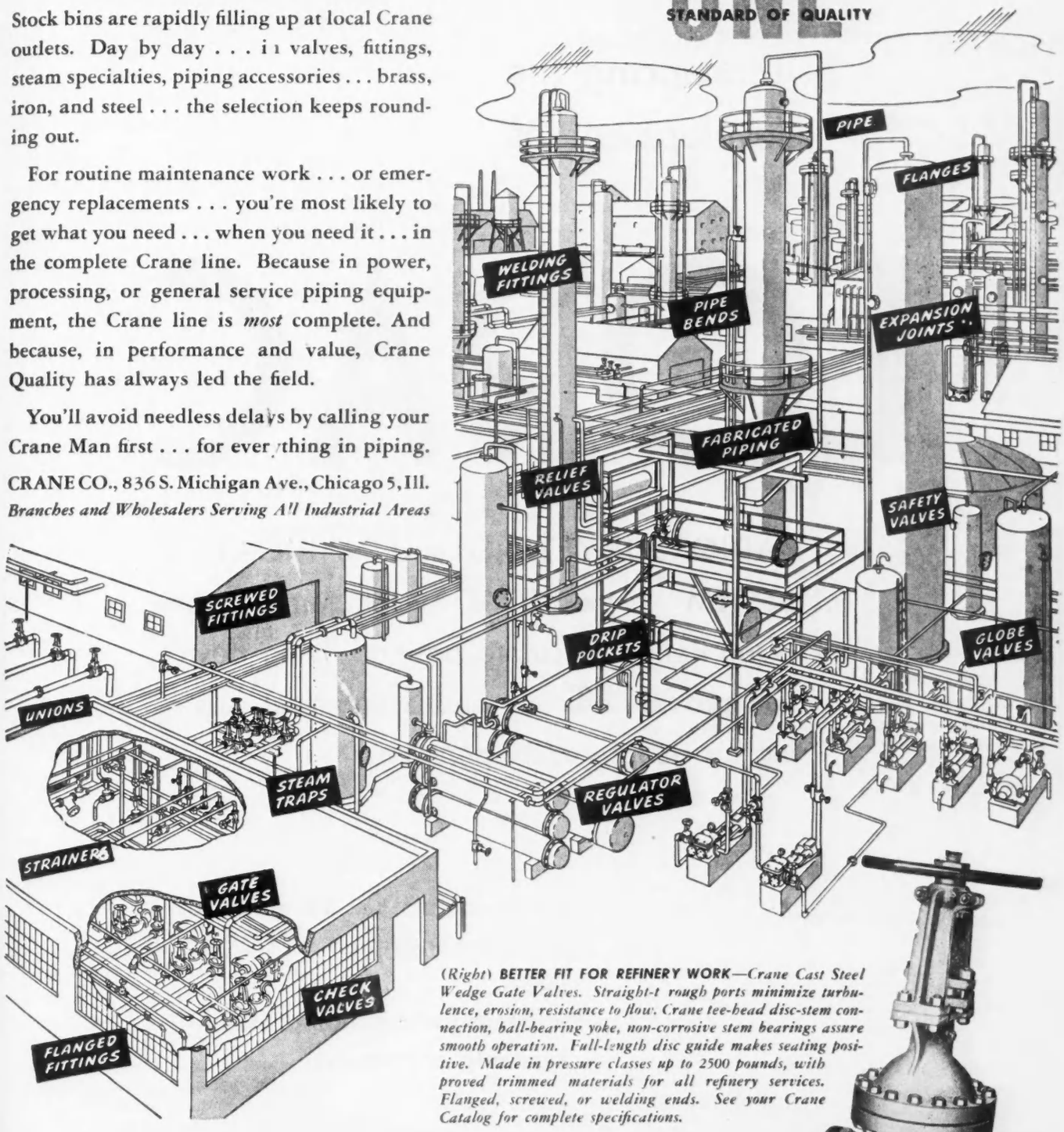

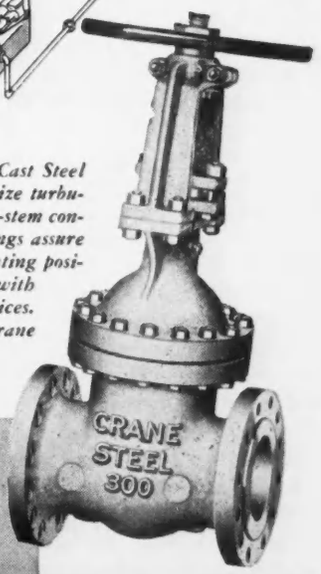

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INCREASED CAPITALIZATION OF *Geological-Geophysical Expenses* WOULD REDUCE EXPLORATION

RISING concern is being felt throughout the petroleum industry over the policy of the Bureau of Internal Revenue to require, for tax purposes, the capitalization of a steadily increasing proportion of expenditures for geological and geophysical exploration work. Recently the Bureau had determined to require 100 percent capitalization of these costs, but under pressure from the Senate Small Business Committee, it agreed on May 26 not to issue a formal ruling without prior notice to the Senate committee. Later the Bureau made the same commitment to the Department of Interior. However, the Internal Revenue Bureau can accomplish the same result by the more devious method of simply issuing informal, unpublished instructions to its field representatives ordering them to require larger and larger amounts of geological-geophysical expense to be capitalized.

The effect of any such policy of so drastically penalizing geological-geophysical exploration in the search for new oil would be a 38 percent tax on the amount spent for prospecting. This policy would seriously discourage the search for oil at the very time when new oil discoveries are most urgently needed for the national security and the civilian economy of the United States. In this sense, the Bureau's policy conflicts directly with the intent of Congress and various departments of the Government to stimulate the search for new oil fields.

For many years it was the practice of oil and gas producers to regard the cost of searching for new reserves as a normal business expense. Actually, this practice was recognized by the Internal Revenue Bureau itself, since it was not until 1942 that the tax on geological-geophysical exploration was first imposed by administrative ruling; and then it was made applicable to all "open years," for which tax liabilities had not then been determined.

At that time the Bureau began disallowance of these prospecting expenses for work which resulted in the acquisition or retention of property in the area surveyed. While the 1942 ruling conflicted with the industry's established accounting practice, the order was not seriously contested because at first it appeared to be the Bureau's policy to require capitalization of only 5 or 10 percent of geological-geophysical expense. Now, however, the Bureau's precedent is extremely dangerous because application of the ruling is becoming increasingly severe. Some recent tax settlements have involved capitalization of 50 percent or more of the total geological-geophysical expense incurred, with the corresponding increase in tax.

In applying the 1942 ruling heretofore, the Bureau has accepted the viewpoint that geological-geophysical expenses capitalized are allocable as part of the cost of acreage acquired or retained following the exploration of any area. Such capitalized expenses applicable to properties later relinquished are deductible when the acreage is surrendered. The industry fears that the Bureau will find some pretext or device for preventing the deduction of capitalized expense at the time of surrender of the acreage to which allocated, and fears that this disallowance may also be made effective retroactively. This creates further operating uncertainty since producers wish to know that their current exploration activities will not result in an indeterminate increase in income tax at some indefinite future date.

Required capitalization of geological-geophysical expenses tends to make prohibitive the leasing and testing of acreage except of first quality, since second-choice acreage would entail income tax increases by an amount many times the value of acreage that otherwise would be acquired or retained. Such a situation would tend to discourage, or to make prohibitive, the testing of any but first quality structures and therefore would drastically restrict discovery of new fields.

As an example, suppose a company spends $100,000 to survey an area and finds weak evidence of structure covering 2000 acres on which the company is willing to take leases at a cost up to $5 an acre but no more. Purchase of the leases would entail capitalization of the $100,000 expense incurred in surveying, and in addition, income tax would be $38,000 greater at present rates than if the exploration expense was deductible. If the 2000 acres are leased, the price would be $74 an acre . . . the total of exploration costs of $50 an acre, lease cost $5 and tax $19. Such a figure would make the purchase prohibitive, or the acreage, if purchased, would be carried on the company's books at a figure wholly out of line with its actual wildcat value.

Similarly, where a company owned substantial amounts of acreage prior to "shooting," it would either have to relinquish that acreage after the survey or pay the added income tax as illustrated above. Thus much acreage not of the first quality would never be tested, although in the past acreage which on the basis of geological and geophysical data appeared to be of doubtful grade, has yielded many million barrels of oil.

Increased capitalization of geological-geophysical expense would reduce the testing of doubtful acreage because there would be fewer "farm-outs" and drilling deals for the small operators who often promote wells on doubtful prospects through dry hole contributions, acreage donations, etc., from the owners of acreage on such prospects. Thus, even the small operators who do not directly engage in geophysical work, a class which in the past has drilled a large proportion of the country's successful discovery wells, would be adversely affected.

The real significance of increasing the required capitalization of geological-geophysical expense is not in the ability of the companies to pay the tax, but the potentially dangerous result that such a policy will have on exploration at a time when the search for oil is of such paramount importance. If the Internal Revenue Bureau does require 100 percent capitalization of exploration costs, either by new ruling or by circumventing its commitment to the Wherry Committee and the Interior Department through the device of tightening its present administrative ruling, industry experts believe that exploration efforts will be hampered and that the long-range result will be the discovery of much less oil than we should find if the industry's exploration work were not so penalized.

Suggestions for Improving the Next Oil Exposition

DURING the progress of the International Petroleum Exposition in Tulsa during May 15 to 22, WORLD OIL representatives talked with a large percentage of the exhibitors and a great many oil men, trying to develop information which might lead to an even more successful Exposition in the future.

WORLD OIL is not attempting to evaluate the criticisms or the lines of praise, but is simply reporting them as faithfully as possible. Any oil man, exhibitor, or Exposition official who wishes to add to the comments or to explain why some of the suggestions are not practical, is invited to write his views to the editor of WORLD OIL.

It appears that practically all exhibitors were well pleased with the results they obtained at the Exposition, the majority expressing satisfaction with the number of interested persons who stopped to study their products or services. However, there was criticism, even from those who expressed overall satisfaction. There also were made several suggestions for improving various phases of the Exposition.

Frequency of Exposition

All exhibitors with whom representatives of WORLD OIL talked were interested in the frequency with which the Exposition would be held, in the length of time it would run, and in the number of hours the Show would stay open each day.

"The Exposition should be held for a two-week period, but should not be held more frequently than every four years," was a statement made by many exhibitors. Several added, "There should be no other oil expositions held elsewhere."

"I fear that if the Exposition were held every four years there would be a loss of continuity which would be damaging," said another. "I for one believe that every three years would be best."

A number expressed the thought that if the Exposition ran for two weeks instead of eight days it would give oil companies and contractors a better opportunity to send more men without disrupting their field operations. At the same time, a longer show might relieve the room situation, they said.

The running of the Exposition from 10 a.m. to 10 p.m. each day is another phase on which a number of exhibitors have expressed views. "The exposition," said one man, "should open at 10 o'clock and close its doors at six o'clock each day. If this were done, it would not be necessary for exhibitors to have so many men at the Exposition at one time, or to work those there to the point of physical exhaustion."

"Closing the Exposition at six o'clock each day would not be harmful," asserted another, "since only the general public and very few oil men attended during the evening hours."

A general complaint was made by most exhibitors against the entry of the public to the Exposition every day. "I sincerely hope that the Exposition will do something to keep the non-oil man away during most of the show," declared one exhibitor.

"You work your head off explaining something to a strange visitor, seeing old-time customers pass by, and then find you are talking to someone not remotely connected with the oil business," said several. "If the public must be invited, one day should be set aside for that purpose and on other days admission should be to oil people only."

"The International Petroleum Exposition is no longer in the bush league class," said one. "It is now big league stuff. There is no reason why admission to the Exposition should not follow the policy of other big industrial Expositions, where the casual curiosity seeker is turned out in favor of the actual customer or prospect. This would cut down the attendance, but I do not believe there will be an exhibitor who would not be very much in favor of it."

Identification of Oil Men

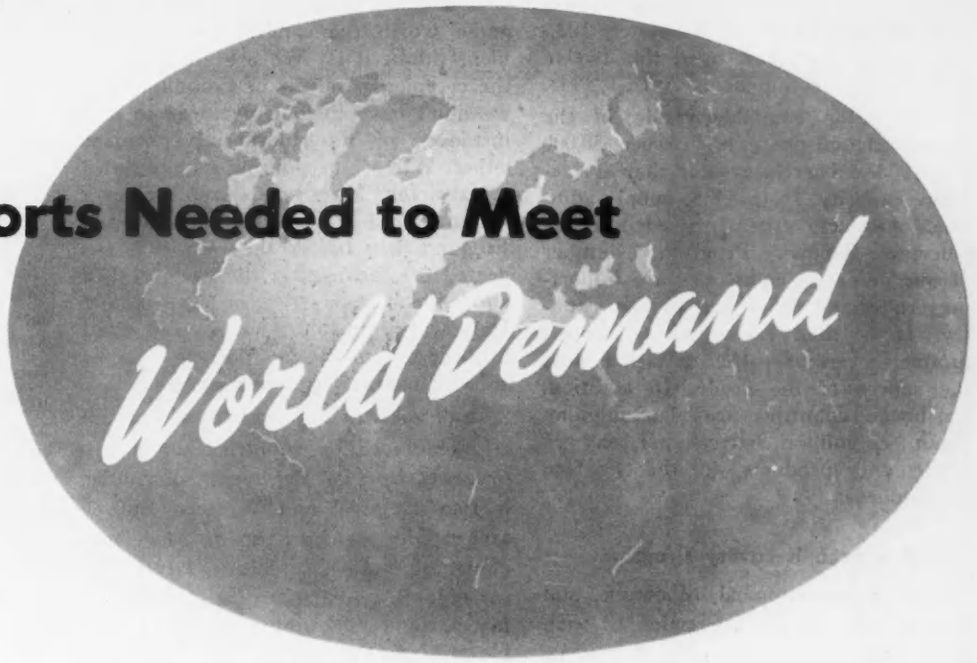
"Something should be done to separate the sheep from the goats," said still another. "We would like to know whether or not we are talking to a man in the production or pipe line or refining branch of the industry. An easy way would be to have each oil man register, and pin a button on him which would designate what he is. For instance, if he is a drilling contractor put a certain color button on his lapel. If he is a pipeliner, give him a button of another color, and so on. One of the oil trade magazines did this a few years ago and it was helpful, but the Exposition ought to do it for the exhibitors."

Another party suggested: "The Exposition could furnish oil companies and contractors with badges for their men who were being sent to the show. If this were done in advance, the man's name and occupation could be written on the badge. It seems to me that the oil companies would also like this idea, as it would assure their men the fullest attention of exhibitors."

"Better management of the restaurant

■ CONTINUED ON PAGE 50

Vigorous Efforts Needed to Meet World Demand



BY R. M. BARTLETT,
Vice President, Gulf Oil Corporation, Pittsburgh

WORLD PRODUCTION of petroleum is now about equal to world demand, the U. S. being now a net importing country. But demand is steadily rising. To keep production up with the increasing demand will require various measures, including the following:

(1). Extensive development of pipe line and tanker transportation facilities for Middle East crude.

(2). Building of refineries in Europe to process crude from the Eastern Hemisphere, under the European Recovery Program. This aims at making Europe more self-sufficient in satisfying its oil requirements.

(3). Continued great exploratory efforts to find new oil, particularly in South America, where tremendous reserves have already been found.

(4). Development of techniques for synthetic production of fuels as a protection against future emergencies.

This article is from an address given before the Fuel Oil Distributors Association of New Jersey at Asbury Park, N. J., April 30.

THE present situation in connection with the supply and demand of petroleum products is not of a limited area. Instead, it is vital to the entire world. We cannot consider local, state, national or even hemispheric conditions; but rather we must recognize that since oil does so much so well, it has a vital effect upon the economic and political well-being of the world. In 1947, world oil consumption was 13 percent greater than 1946, the equivalent of a gain of about 1 million barrels per day, of which slightly more than one-half was in this country.

Unfortunately, supplies of petroleum products to meet the continuing increased demands throughout the globe are not so readily available, and the problem of supply in the U. S. is greatly influenced by the world's requirements and the supplies of crude oil, refinery capacity and transportation.

Up to the postwar period, supply and demand the world over were in fairly good balance. The U. S. produced and refined almost two-thirds of the world's requirements. The Eastern Hemisphere and other parts of the world were supplied from sources closer to them. However, with the war, many of these sources of supply and refineries were destroyed. At the same time, the requirements for oil in all parts of the world have greatly increased.

According to European Recovery Program figures, total petroleum requirements of the program for the fiscal year beginning July 1 will be about 987,000 barrels per day, of which nearly 10 percent will be supplied by the U. S. About 450,000 barrels will come from foreign production of American companies. We must continue to support ERP without seriously jeopardizing our own economy, because the sooner these countries become self-sustaining, the more contented their people will be—and the better off all of us will be.

Production Prospect

In 1947, the U. S. produced approximately 5,100,000 barrels of crude per day, South America 1,600,000 and the Eastern Hemisphere, exclusive of Russia, 1,100,000. This makes a total for both hemispheres of 7,800,000 barrels. This year it is expected U. S. production will be increased by at least 400,000 barrels per day, South America 200,000 and the Eastern Hemisphere, again exclusive of Russia, 250,000. So the world production of crude oil will be 8,650,000 barrels. This is a net global gain of more than 10 percent. We don't know much about Russian production, yet one point is crystal clear, and that is they are not diverting any of their oil to the democratic countries.

Estimates have been made that by 1950, barring unforeseen developments, world consumption might reach 10 million barrels per day.

It is expected that in 1948 the industry in this country will be refining at the rate of about 5½ million barrels per day and in South America and Canada another 1,600,000. In the Eastern Hemisphere, the 1948 rate is expected to reach approximately 1,300,000, making the world total 8,400,000 barrels per day. Taken as a whole, these figures indicate that current consumption and output are almost identical—no opportunity for surpluses to accumulate. It is significant, however, that the U. S. is now firmly established as a net importer. According to a recent Bureau of Mines forecast, it is estimated that our average imports

of crude and petroleum products will exceed our exports by approximately 102,000 barrels per day over the twelve month period commencing April 1, 1948.

Today, the available crude in the Eastern Hemisphere is between 50,000 and 100,000 barrels greater than its refining capacity. In order to supply additional products urgently needed in the European Recovery Program, a number of our domestic companies are importing crude, and refining it in this country. It is then reshipped as refined products overseas—often to nations near the source of the crude. In addition, Caribbean countries are also shipping about ½ million barrels per day of crude and products to the Eastern Hemisphere.

European Recovery Program

This is uneconomical, of course, and it is in part for the correction of such situations that the European Recovery Program has been adopted. It is vitally important, not only to the people in other parts of the world but also to us in the U. S. that refineries be set up at points in Europe or elsewhere to operate on crude from the Eastern Hemisphere. Only by so doing can an ample quantity of petroleum products be made available to those countries, for improving their economic life.

Therefore, it is impossible to consider world demand without placing ERP in a very prominent position. Never before in the history of this country, or any other country, for that matter, has there been a peacetime project even remotely resembling it in size or scope. Between $5 and $6 billion have been authorized, as you know, in order to put the ball in play for the first year, with two or three more years to follow with considerably lesser amounts.

Many lessons have been learned from our lend-lease experiences. No longer is it planned that Uncle Sam is to be the perennial Santa Claus, or, to give it the European flavor, Kris Kringle. This time it is going to be up to the recepient countries to show definitely that these enormous funds will be employed to make them self-supporting.

All this money affects not only our personal income taxes in this country, but also our entire national economy. The more we encourage these aided countries to construct and produce, the less will it be necessary to continue to extend financial assistance. This aid will be carefully channelized, where it will do the most good—not to support them in idleness, but for reconstructing their bombed factories, transportation systems, etc.

Is it going to be worth while? Is the game worth the candle? Our government thinks it is! We are all aware of the creeping paralysis of Communism—we don't have to look overseas to find instances of its smothering presence either. Will we be pouring money down a "rat hole?" More goods are now being manufactured in Denmark, Belgium and England than before the war. It is expected the factories in the war-wrecked and pillaged countries of France and Italy will approach, if not exceed, their pre-war output within the next year or so with continuing American aid.

It all goes to show what money, properly employed by countries anxious to progress, can do. The result, of course, is that England and Western Europe are rapidly catching up to the "machine age." Mines, railroads, farms, factories, etc., are all being modernized as fast as funds, determination of the people, and availability of machinery will permit—and all this must redound to the good of all of us in this country. Higher European prosperity and standard of living will inure to our benefit here. How? Because when Western Europe becomes self-supporting in its oil requirements, as refineries are completed, it will release more of this precious energizing fluid so vital to our own free enterprise system. The U. S. is often referred to as the nation on wheels—let's try to get all the countries included in the ERP not only on their feet, but on wheels, too! According to the Bureau of Mines, the expectation is that our 1948 exports of petroleum products will be about 20 percent less than last year, and each succeeding year we should be called upon to export less gasoline and fuel oil.

Even so, we shall still have problems here in this country. Over the years, our geologists and wildcatters have been able to constantly increase the proved reserves. Last year, in spite of record production, our proved reserves were increased by almost three percent. Experience indicates that as time continues, the discovery of additional reserves in the U. S. becomes more difficult. According to recent testimony before the House Committee on Armed Services, worldwide proved reserves are estimated at more than 76 billion barrels, of which there are about 24 billion in the U. S.

Everyone in this country wants better and faster transportation, cleaner and more convenient heat. Agriculture and industry are constantly expanding their uses for oil. We in America must look to other sources for our crude. Great exploratory projects are under way; and from the results obtained to date, our greatest nearby sources of crude probably are in South America where, during past years, tremendous reserves have been found.

U. S. Imports to Rise

The largest proved crude oil reserves that we know about now are in the Middle East—where there is an estimated 20 percent more than our entire proved reserves in this country. This year it appears that an average of at least 30,000 barrels a day of crude will be brought into this country from the Middle East by several of our domestic companies. In addition, the Navy is picking up substantial supplies from that area, relieving the pressure on domestic oil. It is expected that by 1949, this country will be receiving at least double the 1948 quantity, increasing to approximately 150,000 barrels a day by 1951-52, and possibly ½ million barrels by 1955. It is believed that approximately 600,000 barrels per day will be imported from South America by 1951-52, thus making our total imports by that time about 750,000 barrels, and approximately 1 million barrels daily by 1955, Middle East and South America combined.

At present Middle East pipe lines are carrying about 100,000 barrels of oil per day from Iraq to the Mediterranean. As almost everyone knows, several lines are under construction from the Persian Gulf area to the Mediterranean, and eventually it is expected that 1 million barrels of crude per day will be handled in this manner. Such lines save 2500 to 3000 miles of water transportation. Pending the completion of these pipe lines and even for a short period thereafter, certain studies indicate there will not be sufficient tankers to take care of world demand.

A T-2 tanker with a capacity of 100,000 barrels now requires about 57 days for the round-trip between New York and the Persian Gulf. This means it could deliver crude in New York at the average rate of approximately 1680 barrels per day. One hundred tankers would therefore bring in an average of 168,000 barrels per day of mid-East crude. This is only 1¾ percent of the world demand this year. It is therefore very evident that we need to greatly increase our tanker fleet in order to haul the crude which is required to satisfy the tremendous demand for petroleum products.

While ships are about in balance to meet today's minimum requirements, the margin is too close for comfort, and several companies have included in their budgets provision for the purchase of various numbers of big tankers. However, it takes several years before these tankers can be delivered, and consevration steps must be an essential part of our economy, in order to avoid spot

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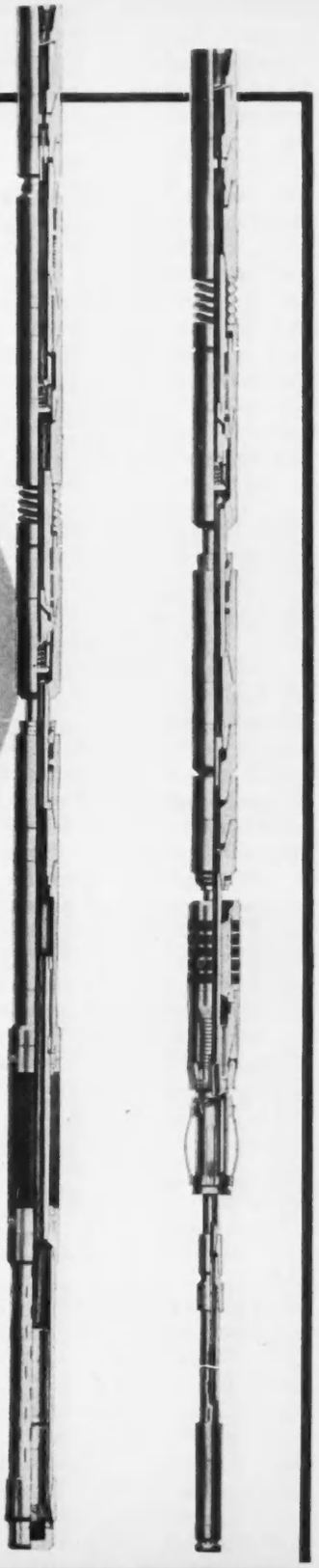

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Safety . . . patented equalizing valve permits pressure to be equalized above and below packer before it is raised from its seat. This is an *exclusive* feature that expedites pulling packer and prevents excessive strain on rig equipment and pipe.

Accuracy . . . disc valve prevents drilling fluid from contaminating formation fluid and further differentiates between formation fluid and drill pipe leaks . . . another *exclusive* Johnston feature.

Reliability . . . proved in successfully testing thousands of wells throughout the world.

And to complete the picture, the Johnston Pressure Recorder charts *all* pressures going in and coming out of the hole, including hydrostatic pressure of fluid column, flow pressure and bottom hole shut-in pressure.

Trained, competent Johnston representatives are at hand, always available to serve you. Call them for the ultimate in testing safety, accuracy and reliability.

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FORMATION AND JOHNSTON CASING TESTING

shortages during the next year or two.

Another important phase which must be considered in connection with the importation of crude is that for each ton of steel used, from five to ten times as much oil can be produced in countries outside the U. S. as can be produced domestically. The reason for this is the comparatively shallow oil fields from which the Middle East oil comes, and the tremendous volume of oil per well. In making this statement, full regard is given to the steel required for transportation of the crude to the refineries of this country and to other areas where the finished products are needed. The average daily production of crude in the U. S. is about 12 barrels per well; in Venezuela, about 250 barrels; and in the Middle East, about 4000 barrels.

It is therefore quite obvious how important it is for us to have a foreign policy that will support the operations of American oil companies in the Eastern hemisphere. Any break in our relationship with those countries, resulting in the loss of Middle East crude, would have a calamitous effect on our domestic supply program. This might immediately necessitate rationing, far deeper than ever before, if we attempted to still supply the countries to which we are committed under the ERP.

The world has tremendous reserves of oil. Our scientists, engineers, and technologists are capable of developing ways of discovering it, of bringing it to the surface, refining it, and transporting it. The oil industry has announced plans to spend $8 to $10 billion over the next two years in an effort to meet the world-wide demand.

May Need Synthetic Oil

No consideration of the world petroleum supply picture would be complete without a look at the progress which has been made in synthetic fuel research and what we might expect from it in the future. We are using our crude oil reserves at a high rate. But there is another reason for synthetic fuel research which may be more urgent than the conservation of our crude reserves. That reason is the possibility that our foreign sources of crude may be cut off by war. We would only be deceiving ourselves if we closed our eyes to these possibilities, and the oil industry and the government have been cooperating during the past few years on the problem of making our country self-sufficient.

There are three chief methods of producing synthetic fuel or gasoline: (1) from natural gas; (2) from coal, and (3) from oil shale.

Production of synthetic fuel from natural gas is subject to various disadvantages: (1) It uses up about 50 percent of the British thermal unit value of the gas to convert the remaining 50 percent into gasoline; (2) the plants are costly; (3) they require large quantities of steel; and (4) they consume a large quantity of water for cooling, etc., which is not always easy to obtain.

The method of conversion from coal also has the following disadvantages: (1) It consumes about 60 percent of the Btu value of the coal to convert the remaining 40 percent into gasoline; (2) the plants are costly; (3) they require large quantities of steel; and (4) there is no indication that the plants would be economic at the present time.

One of the most intriguing directions for synthetic fuel development to take is the extraction of oil from shale. This shale is not suitable for any other purpose, and therefore any fuel recovered from it is a net addition to our national fuel resources and not a waste. The process apparently requires only a moderate amount of steel and water. However, crude shale oil is poor in quality compared with petroleum, and it is expensive to refine. Nevertheless, research along this line would seem to be warranted and qutie logical, since we must take a long look forward and be prepared for emergencies. At present, the production of shale oil would no doubt require a government subsidy, as no company is likely to gamble huge sums when this product still has to compete with crude petroleum.

The erection of pilot plants for the production of synthetic fuels by the several methods has been authorized, and a proposal has even been made in Congress to erect three commercial plants, each having a capacity of at least 5000 barrels per day. It is the opinion of our research officials that the erection of commercial plants at this time is not justified. This would rob the petroleum industry of badly-needed steel and produce much less oil per ton of steel invested. Nevertheless, research should be vigorously prosecuted in pilot plants which require relatively small quantities of steel. Continued work will eventually reveal the one or two best methods for synthetic oil production when we need it. Present research projects will be completed in about three years. Then the building of commercial plants should be considered in the light of technological advances made in that period.

Suggestions for Improving the Next Oil Exposition

■ CONTINUED FROM PAGE 44

would help, suggested one exhibitor. "Frequently when the waiting line extended a block, half the tables on the cafeteria side were vacant. This could be cured by having more than one serving line."

"Why not have a cafeteria only?" asked one. "The service could be vastly speeded up by doing this."

Many exhibitors who want more space declared that "the Exposition will have to take in some more land before the next show is held."

On the credit side of the ledger, there was general praise for the amount of space allocated for auto parking.

Praise was had, too, for the manner in which Tulsa citizens opened their homes, although the feeling was expressed by many that the housing committee failed to let oil companies and exhibitors know in sufficient time that they were to be taken care of. This cut down the attendance.

The experience of those who went to the Exposition in special railroad cars which were parked on sidings downtown was on the whole favorable, although some had expected to be parked near to the Exposition. Some believed that this type of housing might well be expanded for the next Exposition.

Housing Facilities

Others said that the housing committee should not only register but visit and rate the rooms in private homes which were offered for occupancy. It is WORLD OIL's understanding that this was done, but some were under the impression it was not done in all cases.

The matter of whether or not the downtown hotels should be entirely reserved for oil men, with exhibitors using rooms in private home, came in for a lot of discussion. One exhibitor complained that the big exhibitors got most of the rooms in downtown hotels. Others said in effect "The more oil men attending the Exposition, the better an Exposition it is from the exhibitor's standpoint. Therefore, it is up to the exhibitors to take the private home rooms. Exhibitors' employes generally stay for the entire Exposition, whereas an oil man does not. By handling the housing in this manner, many more oil men could be accommodated."

But there were those who disagreed with this policy. "We want some place where we can take our customers after the Exposition closes each day and talk privately," they argued. "We might even want to give the customer a drink, although we are glad to say that the practice of heavy entertainment on the part of exhibitors seems to be decidedly on the wane. We would not feel free to take a person or several persons to a room in a private home and open a bottle, and even if the entertainment or the conference were strictly dry, the usual home bedroom is not a suitable place."

Giant's Grip . . . with Feather Touch

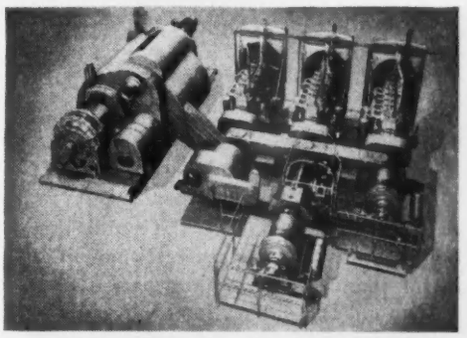
Airflex Principle Gives You Top Flexibility of Power Control

The "giant's grip with a feather touch" has amply proved the money-saving advantages of the Airflex principle on drilling rigs. That's why leading manufacturers now use Fawick Airflex clutches on modern oil field equipment.

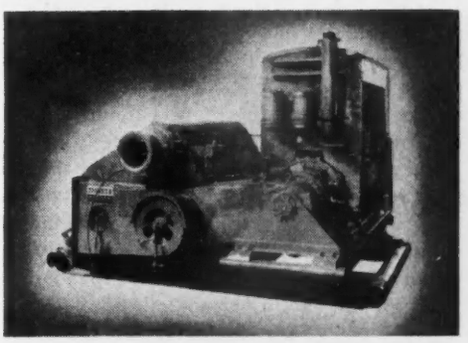
Fawick clutches provide the exact degree of grip or slip required regardless of load or inertia. They give you instant, automatic, positive control of power at the flick of an air valve.

Fawick clutches transmit torque through friction blocks carried on a rubber-and-fabric tube actuated by air pressure. Both prime mover and driven unit are protected against unnecessary breakage, undue wear and tear and needless down time.

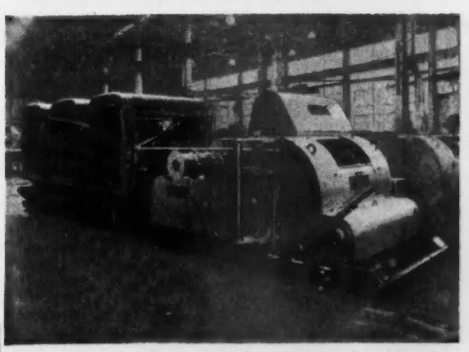
Get more production at lower cost—specify Fawicks on the next equipment you buy.



Oil Well Supply Co., No. 96 Hoist and No. 1000 Triple Engine Drive, with 9 Fawick clutches.



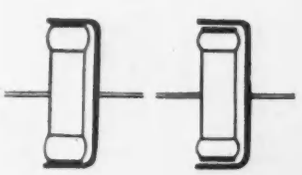
Brewster Co. Model N-4 Rig, equipped with 3 Fawick clutches.



Unit Rig and Equipment Co. Model U-15 Rotary Rig, with 3 Fawick Engine Clutches.

HERE'S HOW IT WORKS

Compressed air expands the rubber-and-fabric gland to engage clutch with any degree of "grip" you want. Release the air and clutch disengages.



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Mid-Continent Supply Co., Ft. Worth, Texas

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OUR LIBRARY ...and Yours!

A cordial invitation to men in the industry to visit and use WORLD OIL's Expanded Library

By RAY L. DUDLEY, Publisher

IT IS an axiom that the publishing business involves certain responsibilities in the maintenance of information files, first to aid the publication's editors, and second for such other benefits as may result.

When the Gulf Publishing Company, publishers of WORLD OIL, designed its plant and office building nearly 20 years ago, a library was considered a must, but as the years went by, it was found that the original conception of space for a library was entirely inadequate, and that as a result of cramped space, important data were accumulating in files located in more than 20 offices. Consequently, when the editorial offices were expanded through an addition to our building slightly more than a year ago, first consideration from a library standpoint was given to ample space.

The strength of a technical library does not necessarily lie in the bound volumes of that library, but may lie in its filing cabinets and the indexing and cross-indexing method followed. So a room was provided with a maximum capacity of 72 filing cabinets (which are not all in as yet because that number is not needed at present).

In preparation for the removal to the library of all desired matter two years were spent in re-assembling the material and indexing and cross-indexing it. Since a technical library cannot be maintained with unskilled help, a professional librarian was employed. Wall space for books and bound files of publications frequently referred to was included.

Today the library is still far from complete, but it is growing every week. As articles appear in WORLD OIL and other oil publications, reference to the bibliography is made by the librarian, and if the source material is not already in the library, an attempt is made to secure it and index it properly.

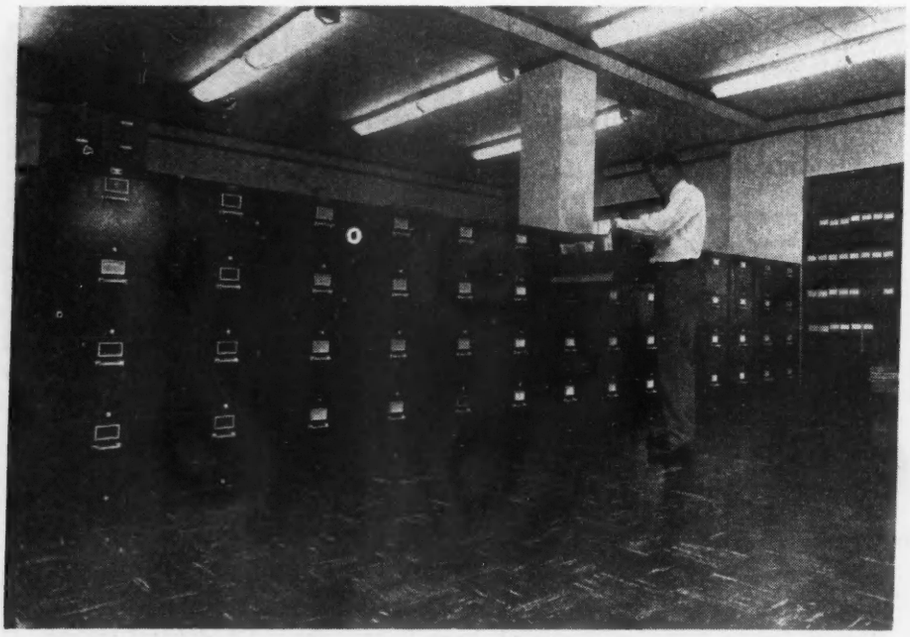
The foreign section is particularly complete, as has been noted by visitors who have had occasion to inspect it. Every country in the world where there is oil development or even a prospect of an oil development has its folder—usually from three to ten folders, each dealing with a particular phase of that country's prospects or development.

The subdivision folders in a specific foreign file usually include concessions, petroleum laws, data on operating companies, field data, geology, detailed maps of special areas, production, refining, and reserve information, and even information on recorded oil seeps or other indications of the occurrence of petroleum, plus all data which have been published on any subject relating to oil in that particular country.

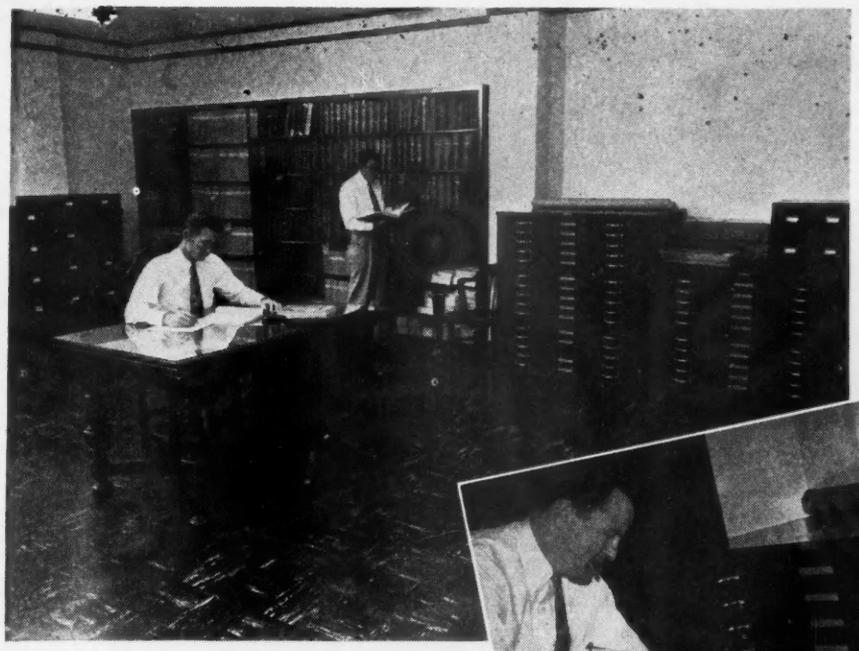
The files relating to various oil problems, operations, etc., quite naturally occupy most of the filing space. Every subject relating to oil on which material has been published for the past several years has its folder. Many of the folders contain special bulletins and unpublished data developed through interviews or correspondence.

The card index system, both for indexing and cross reference, already numbers more than 20,000 cards. The current magazine files contain more than 60 publications including eight foreign ones.

While the bound volumes (including



The general files.



LEFT: Many technical volumes are available.

BELOW: Checking map for an oil field location.

those of publications) number only about 1000 books, these books represent practically every book relating to oil now not out of print.

Oil company financial reports dating back many years are maintained in special cabinets.

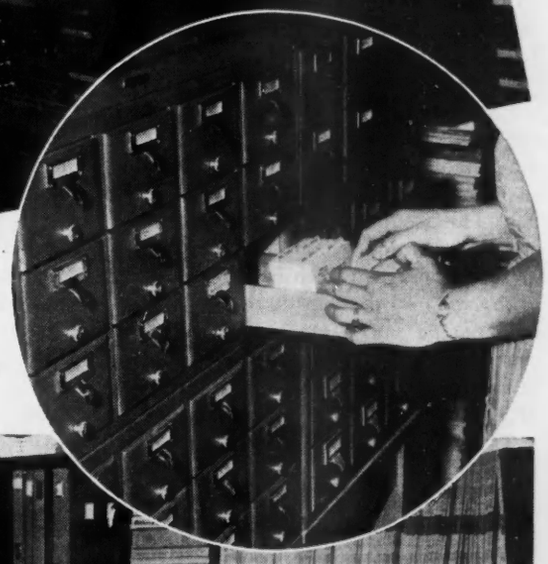
Several steel cabinets contain the photographs and biographical sketches of approximately 8000 persons engaged in the oil business. That is why WORLD OIL and its sister publication, *Petroleum Refiner*, are in a position to carry immediately the photographs of men who have helped to make the news of the industry.

The library has proved a lifesaver on more than one occasion. For instance, a State Department interview some time ago made reference to a certain contract between an oil company and a foreign government. When the interview came into the editor's office, it was checked against the copy of the contract in the files and a serious mistake was avoided.

The editors are instructed to "check with the library first" when writing a special article, and much time is saved thereby in getting the basic data upon which the new data is to be superimposed.

But while the library is primarily for the use of our own staff, it is open to the oil public with one string attached . . . no book, file, manuscript, clipping, bulletin or map may be taken from the room. Every facility is provided for the visitor to use the material in the library, even a drafting board. Such usage helps us as well as the visitor, because from our visitors have come many excellent suggestions as to improvement.

The library is located on the second floor of the Gulf Publishing Company's building at 3301 Buffalo Drive in Houston.

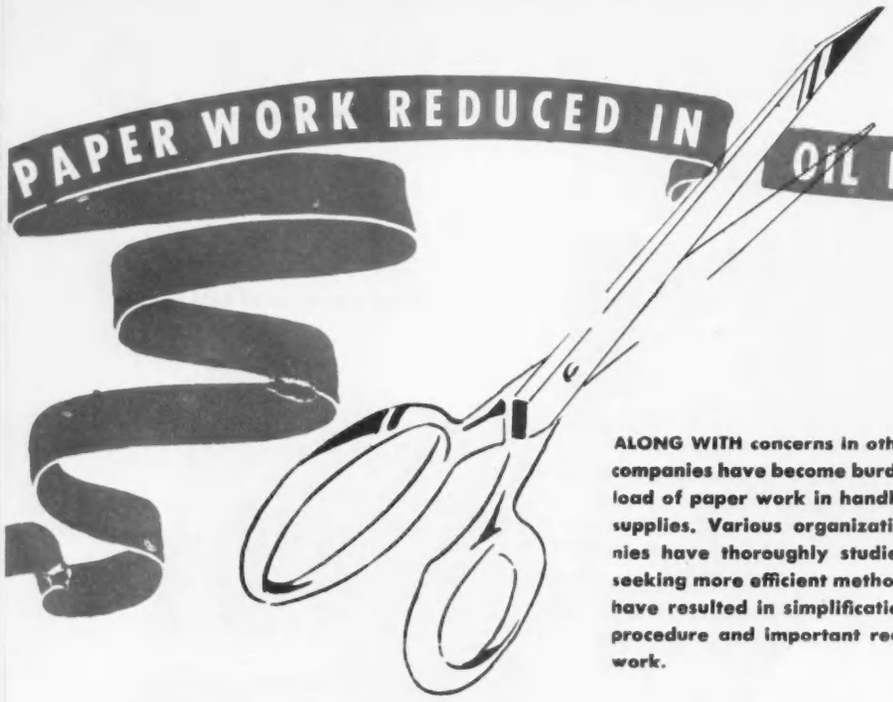


RIGHT: Consulting the card catalog for references.

BELOW: The librarian, Mrs. Kathryn Crouch.

PAPER WORK REDUCED IN OIL INDUSTRY PURCHASING

By Henry Ozanne
Staff Writer



ALONG WITH concerns in other industries, oil companies have become burdened with heavy load of paper work in handling purchases of supplies. Various organizations and companies have thoroughly studied this problem, seeking more efficient methods. These studies have resulted in simplification of purchasing procedure and important reduction of paper work.

AMERICAN industry has become saddled with a "paper work" load to the point where insistent attention is being given the problem of streamlining purchasing procedure. The National Industrial Conference Board has made a recent study of the situation and has suggested possible solutions for suppliers, while in the petroleum industry the Petroleum Equipment Suppliers Association has discussed the same problem. The association was advised that a study of invoices shows that 80 percent of the "paper work" in its field is taken up by only 20 percent of the dollar volume of the purchases involved. In the case of one supply company 50 percent of its invoices were for only 1½ percent of its dollar volume.

Tabulations of individual purchase and sales transactions in many industries reveal that 50 percent of the entire paper work involved represents, perhaps, less than 5 percent of the over-all dollar volume. In the purchase of maintenance, repair and operating supplies, short cuts can be taken to reduce paper work. For instance, wherever direct contact exists between a buyer and seller, resulting in an itemized delivery receipt being prepared by the seller and signed by the buyer, individual purchase orders can be wholly eliminated. Resulting invoices can be accompanied by a copy of the signed itemized delivery receipt, thereby eliminating the requisition, confirming purchase order and/or the preparation of an individual receiving record. Invoices can be consolidated on a weekly, semi-monthly or monthly basis wherever repetitive purchases warrant.

Under this plan purchasing control is maintained through the issuance of blanket order or letter authorization on the part of the buyer establishing the identity of individuals authorized to purchase, and containing price reference data and invoicing instructions. In instances where this procedure has been effected, a reduction of 40 percent in the number of purchase orders has been achieved, as well as a corresponding reduction of a 33-1/3 percent in the number of individual invoices received.

The petroleum industry began to feel the full impact of the "paper work" load during World War II with the regime of governmental controls and generally disturbed market conditions. This problem has persisted since the war and in many ways has grown more acute.

Programs Designed

In 1945 and after a detailed study of the over-all problem, the purchasing department of one of the major oil companies designed three programs to streamline and standardize the procurement procedures relating to certain types of purchases for the mutual benefit of the operators and the purchasing department. These programs as now approved and adopted comprise:

1. Blanket order and counter-slip arrangement—primarily for use by the producing department.

2. Orderly requisitioning procedure—principally for use by the refining department at plants maintaining extensive inventories of storehouse stocks.

3. The field purchase order—for use by all departments in making local purchases, or as release against purchasing department contracts or blanket orders requiring releases.

In April, 1946, instructions went to the purchasing officials of all the divisional offices of this company specifying the accounting procedure that was to be adopted.

1. In the case of the blanket order and counter-slip arrangement, invoices in quadruplicate, supported by a copy of the delivery receipt bearing the signature of the producing department representative receiving the material, are obtained from the supplier.

2. Upon verification by the purchasing department of prices and materials detailed by the delivery slip with those itemized by sellers' invoices, invoice reference is posted on the reverse side of the blanket order, supplemented where necessary with continuation posting media previously furnished.

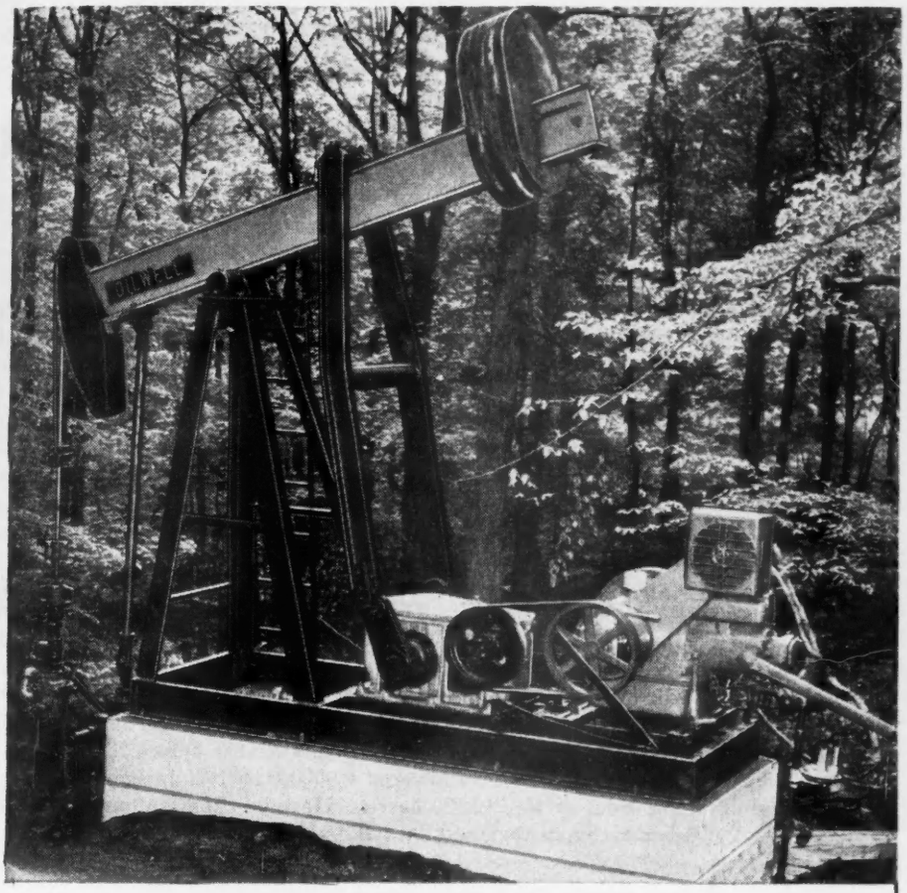
3. Approved invoices are distributed as follows:

(a) Original with supporting counter slip to consignee.
(b) Invoice copies, in duplicate, to producing department divisional manager or chief clerk.
(c) One copy of invoice retained for purchasing department files.

The company's producing department at a recent meeting reported a 69 percent reduction (equivalent to 857 man-hours) in the number of field orders issued during the trial period of the blanket order and counter-slip arrangement.

These programs have not yet been in use long enough to determine the ultimate benefits available, nor has the supply situation to date been such as to permit the full utilization of the plan. Even so, certain substantial benefits are evident. The company in its domestic

■ CONTINUED ON PAGE 62



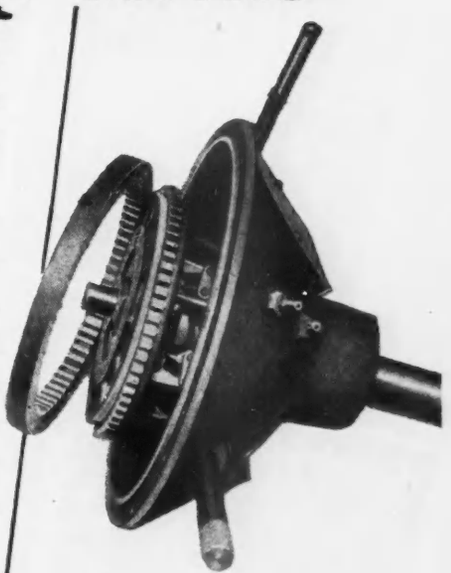
Witte Model B horizontal gas-gasoline engine driving an Oilwell TC-8B Pumping Unit through a Twin Disc Power Take-off.

High Capacity for *Continuous* Service

Twin Disc Power Take-offs are built for jobs demanding high capacity and continuous service . . . for example: the continuous, day-and-night operation demanded in oil-field pumping applications.

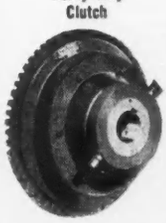
Most nationally-known engine manufacturers and builders of oil-field machinery and material-handling equipment offer Twin Disc Power Take-offs as standard equipment. Sizes of Twin Disc Power Take-offs range from 6.5″ to 24″, single plate, and from 11.5″ to 24″, double plate. Housing sizes are from No. 6 SAE to No. 00 SAE . . . capacities up to 650 hp. For complete specifications write for Bulletin 129-B.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin
(Hydraulic Division, Rockford, Illinois).

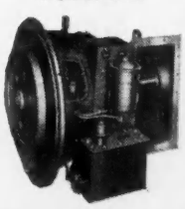


Twin Disc Power Take-off

Heavy Duty Clutch



Hydraulic Torque Converter



Hydraulic Coupling

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CLUTCHES AND HYDRAULIC DRIVES
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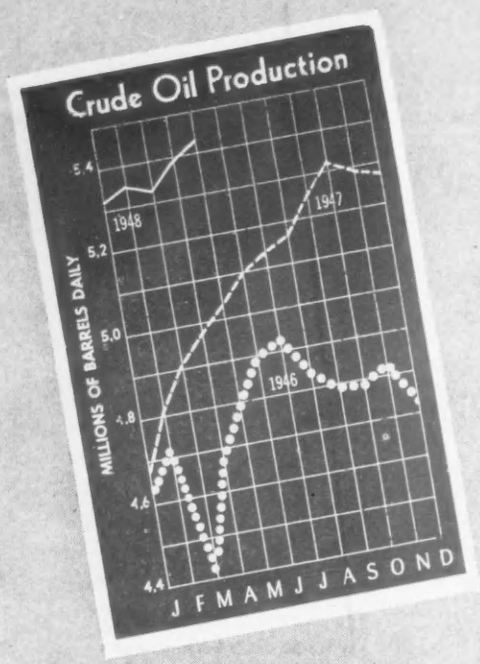
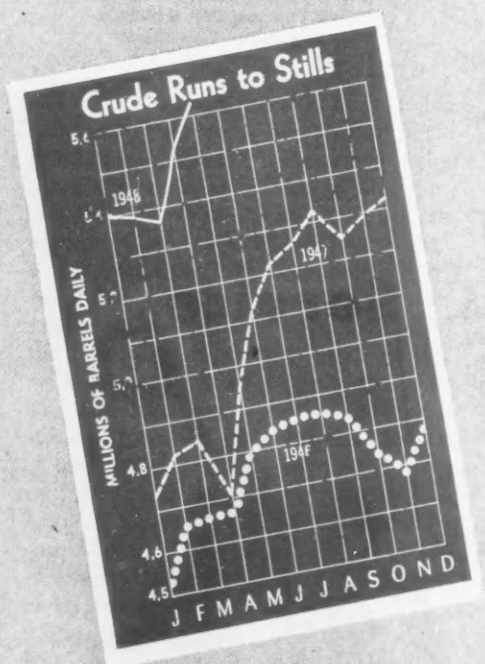
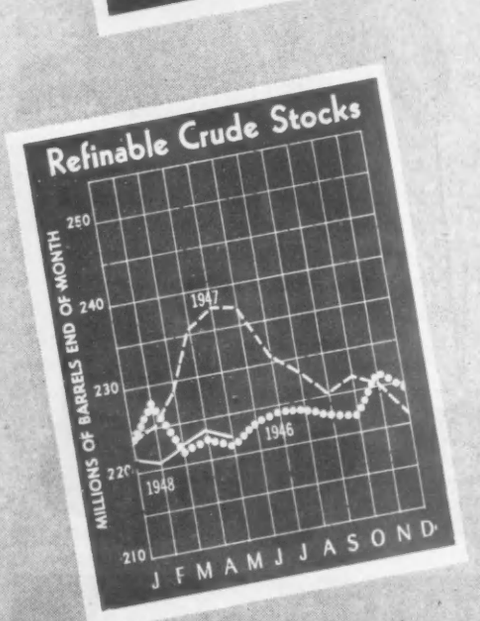
Reduction Gear

Marine Gear

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918







Three All-Time High

THREE all-time high marks fell in May as the oil industry completed its most active producing and refining month in its history. New peaks in crude production and refinery throughput have been hit almost every month since they both rounded the five-million-barrels-a-day corner a year ago, and May saw the trend continued. But along with these two old regulars went a third new entry in the record book, a new high in gasoline manufacture. The month's motor fuel output far outstripped production at any time during the recent war in which gasoline played so large a part, as the industry's refiners currently wage their own battles against possible summer shortages. Even with record output, parts of the nation may not be able to escape temporary shortages of gasoline during the peak of the summer's motoring season, but this will be mostly the results of inadequate distribution rather than lack of supplies.

Refiners continued to operate their equipment at near capacity during May and succeeded in averaging 5,640,000 barrels a day throughput. That amount topped April's record high by 104,000 barrels a day and was 693,000 barrels more than was processed daily in May, 1947.

As a result of these record runs to stills, gasoline output hit a new high of 2,472,000 barrels per day, 113,000 a day over production in April and 344,000 barrels more than was produced daily a year before. Despite this high yield, gasoline stocks were lowered 4,348,000 barrels during the month, ending at the total of 107,212,000 barrels. However, that amount was still 12,003,000 barrels more than was on hand at the end of May of last year.

Crude Oil and Refined Products Trends
(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1945:									
January	4,756	4,680	221,737	2,094	91,666	663	31,895	1,350	44,347
February	4,767	4,817	220,221	2,194	97,457	724	27,210	1,326	39,760
March	4,804	4,719	223,988	2,124	97,447	675	26,729	1,273	35,451
April	4,807	4,774	224,229	2,127	90,804	681	29,148	1,289	34,418
May	4,887	4,913	223,151	2,179	88,530	708	29,511	1,341	34,333
June	4,859	4,989	218,218	2,166	86,128	730	32,440	1,351	35,606
July	4,897	5,001	216,638	2,281	85,582	713	36,276	1,351	38,341
August	4,870	4,928	215,135	2,269	84,003	701	41,245	1,329	42,227
September	4,423	4,275	220,319	1,933	74,574	640	45,059	1,139	42,822
October	4,284	4,244	221,246	1,858	76,805	613	45,479	1,176	42,068
November	4,517	4,624	218,916	2,156	86,540	665	44,562	1,265	41,322
December	4,472	4,574	218,763	2,056	97,676	683	35,778	1,245	37,158
1946:									
January	4,625	4,520	223,442	1,914	102,394	787	28,990	1,224	34,573
February	4,719	4,651	227,220	1,884	104,836	823	25,511	1,243	34,008
March	4,414	4,661	221,400	1,900	104,161	816	29,922	1,213	32,995
April	4,673	4,663	222,480	1,943	98,744	773	32,064	1,247	35,206
May	4,785	4,794	221,592	2,016	93,960	753	33,385	1,220	38,932
June	4,896	4,836	223,140	2,055	91,971	777	38,824	1,219	41,492
July	4,922	4,856	224,351	2,102	87,778	793	46,439	1,163	45,446
August	4,836	4,856	224,157	2,189	86,745	765	54,068	1,159	48,186
September	4,790	4,839	222,417	2,143	87,021	796	62,019	1,150	54,012
October	4,785	4,736	222,177	2,117	85,952	788	76,780	1,090	55,580
November	4,823	4,684	226,453	2,162	88,587	791	68,145	1,101	52,735
December	4,725	4,780	224,473	2,168	92,742	805	59,912	1,159	47,094
1947:									
January	4,671	4,739	223,848	2,078	99,623	778	48,197	1,174	41,550
February	4,810	4,820	225,121	2,089	103,672	777	36,901	1,228	48,480
March	4,908	4,843	228,981	2,076	105,679	825	31,423	1,222	37,408
April	4,974	4,707	235,710	2,037	101,724	764	30,268	1,148	36,455
May	5,033	4,947	237,768	2,128	95,209	805	34,279	1,204	39,992
June	5,099	5,120	237,278	2,258	89,774	807	39,676	1,233	43,515
July	5,137	5,221	230,974	2,302	86,003	847	46,444	1,244	47,600
August	5,173	5,260	228,523	2,383	85,849	869	54,707	1,245	51,334
September	5,251	5,236	225,258	2,375	84,360	911	59,764	1,237	52,578
October	5,320	5,253	226,666	2,371	82,584	938	63,252	1,260	52,502
November	5,291	5,291	225,462	2,332	87,551	942	61,334	1,245	52,455
December	5,337	5,350	224,929	2,347	92,303	992	51,081	1,282	47,091
1948:									
January	5,283	5,348	223,430	2,328	102,167	1,082	41,036	1,278	44,636
February	5,353	5,380	224,880	2,264	110,999	1,127	34,590	1,295	43,156
March	5,406	5,387	227,408	2,252	111,949	1,050	32,214	1,307	41,945
April	5,398	5,536	222,944	2,359	111,560	1,018	35,083	1,290	43,605
May	5,434	5,640	221,698	2,472	107,212	1,005	39,333	1,324	48,100
May, 1948 Change:									
In Month	+36	+104	—1,246	+113	—4,348	—13	+4,250	+34	+4,495
In One Year	+401	+693	—16,070	+344	+12,003	+200	+5,054	+120	+8,108
In Two Years	+649	+846	+106	+456	+13,252	+252	+5,948	+104	+9,168

Marks Broken in May

Crude oil production averaging 5,434,000 barrels daily in May bettered April's all-time high by 36,000 barrels daily and topped that of May, 1947, by 401,000 daily. However, this peak production, along with imported crude, failed to meet the demands and crude oil stocks were drained of 1,246,000 barrels to make up the deficit. Stocks of refinable crude oil totaled 221,698,000 barrels at the end of the month, 16,070,000 barrels less than a year before.

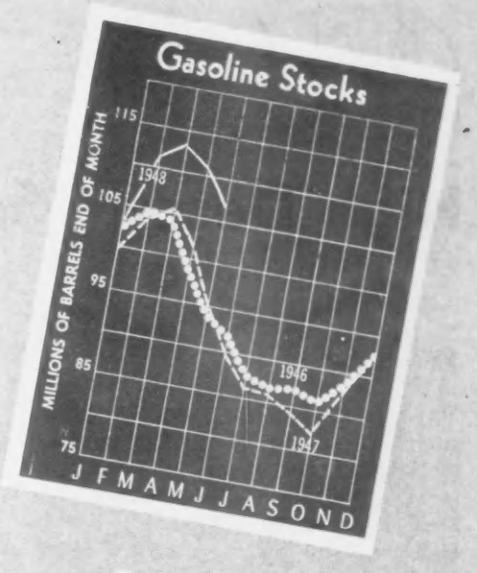
Further evidence of the shortness of crude oil supplies is the increasing frequency and size of premium payments being made for material. Refiners who do not own production and must buy their crude supplies are bidding up the price. Also competing for these supplies are the exporters, who have long been paying cash premiums, though with the tightening of export permits, these premiums have been lessened. Some industry sources have estimated that 135,000 barrels of crude a day are currently being bought in Texas, Louisiana, New Mexico, and Arkansas at cash premiums. These bonuses range up to 35 cents per barrel and probably average about half of that amount. Six months ago top premiums were 25 cents and the volume sold under those conditions was only 70,000 to 80,000 barrels daily.

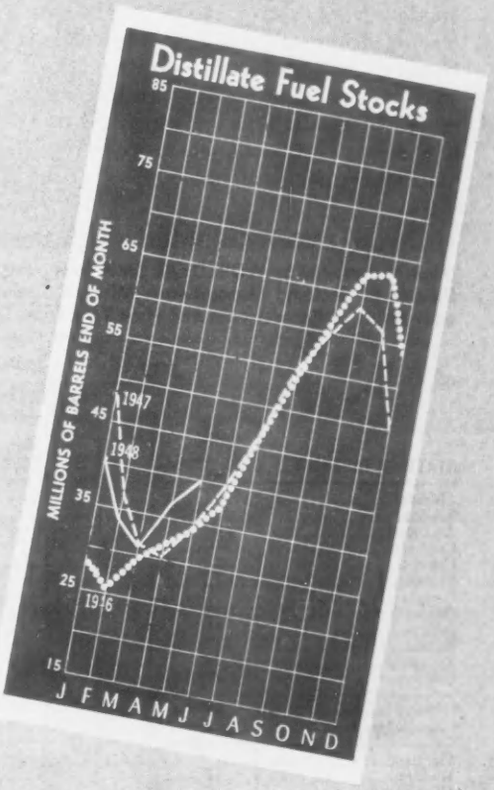
While the amount of crude being purchased with cash premium payments is more easily estimated, it is believed by some that almost a like amount is going by way of other types of payments, such as drilling contracts, lending of money and pipe. With the ranks of bonus payers and the amounts being paid increasing, it seems quite probable that the very near future will see a general crude price hike. Just when and by whom it will be initiated is, of course, unknown, but when major buyers either lose or are threatened by loss of field connections this upward pressure will begin to show effects.

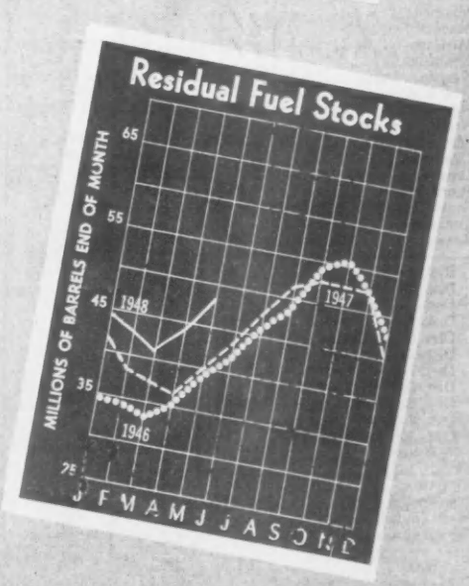
State Crude Oil Production

THOUSANDS OF BARRELS

STATE OR DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL FIRST FIVE MONTHS		
	May, 1948	April, 1948	May, 1947	% Diff. May '47-'48	1948	1947	% D'ff. '47-'48
Alabama	1.4	1.1	1.2	+ 16.7	189	147	+ 28.6
Arkansas	83.0	82.1	81.1	+ 2.3	12,851	12,138	+ 5.9
Calif rnia	947.1	941.8	912.4	+ 3.8	142,688	136,126	+ 4.8
Col rado	47.5	45.6	40.9	+ 16.1	6,930	5,779	+ 19.9
Fl rida	0.7	0.8	0.7	.....	119	68	+ 75.0
Illinois	172.8	172.6	182.5	— 5.3	26,320	28,308	— 7.0
Indiana	20.7	19.5	16.8	+ 23.2	2,514	2,588	— 2.9
Kansas	299.5	295.6	288.2	+ 3.9	43,882	42,179	+ 4.0
Kentucky	25.3	24.6	25.2	— 0.4	3,717	3,821	— 2.7
Louisiana	466.3	463.7	432.6	+ 7.8	71,631	63,935	+ 12.0
North Louisiana	111.6	109.3	99.0	+ 12.7	17,107	14,740	+ 16.1
South Louisiana	354.7	354.4	333.6	+ 6.3	54,524	49,195	+ 10.8
Michigan	44.9	44.9	42.8	+ 4.9	6,844	6,446	+ 6.2
Mississippi	123.0	121.1	91.2	+ 34.9	18,121	13,169	+ 37.6
Missouri	0.1	0.2	0.2	— 50.0	23	22	+ 4.5
Montana	23.2	23.2	23.6	— 1.7	3,606	3,457	+ 4.3
Nebraska	0.5	0.5	0.5	.....	79	93	— 15.1
New Mexico	126.6	128.1	106.9	+ 18.4	19,345	15,935	+ 21.4
New York	13.7	14.0	12.9	+ 6.2	1,980	1,947	+ 1.7
Ohio	9.8	9.7	8.2	+ 19.5	1,361	1,203	+ 13.1
Oklahoma	419.8	406.9	379.1	+ 10.7	61,550	56,586	+ 8.8
Pennsylvania	33.9	34.8	34.9	— 2.9	5,193	5,197	— 0.1
Tennessee	.....	.....	.....	.....	3	3	.....
Texas	2,421.1	2,417.9	2,225.2	+ 8.8	365,372	319,507	+ 14.4
Dist. 1—South Central	26.9	25.8	21.1	+ 27.5	3,934	3,061	+ 28.5
Dist. 2—Middle Gulf	172.0	172.2	159.1	+ 8.1	25,987	22,760	+ 14.2
Dist. 3—Upper Gulf	493.1	493.2	484.8	+ 1.7	75,156	69,927	+ 7.5
Dist. 4—Lower Gulf-S.W.	255.6	253.4	243.3	+ 5.1	38,685	34,926	+ 10.8
Dist. 5—East Central	46.4	46.0	38.3	+ 21.1	6,817	5 581	+ 22.1
Dist. 6—Northeast	425.8	438.2	450.2	+ 5.4	65,670	65,037	+ 1.0
Dist. 7-B—North Central	45.2	44.4	38.1	+ 18.6	6,710	5,485	+ 22.3
Dist. 7-C—West Central	45.0	44.4	36.8	+ 22.3	6,700	5,072	+ 32.1
Dist. 8—West	688.0	678.6	527.1	+ 30.5	102,046	73,193	+ 39.4
Dist. 9—North	138.5	137.5	137.7	+ 0.6	21,256	19,564	+ 8.6
Dist. 10—Panhandle	84.6	84.2	86.2	— 1.9	13,092	12,709	+ 3.0
Virginia	0.2	0.1	0.2	.....	20	38	— 47.4
West Virginia	7.9	7.7	6.8	+ 16.2	1,118	1,043	+ 7.2
Wyoming	144.9	141.4	118.9	+ 21.9	21,531	17,170	+ 25.4
Total United States	5,433.9	5,397.9	5,033.0	+ 8.0	816,987	736,905	+ 10.9







Completions

High Despite Sectional Drops

WELLS completed in the U. S. during May totaled 3170, just short of the 3186 completed in the previous month for the highest mark so far this year. The month's work was creditable not only because it almost measured up to April's high, but because it was done while substantial drops were occurring in the two leading drilling states, Texas and Oklahoma. The majority of the other states were able to improve on their previous month's records. This was especially true in the case of Illinois, where wells completed were almost doubled.

The 3170 wells completed in May topped those drilled in the same month of last year by over 25 percent and boosted this year's five-month total to 14,516 wells, an increase of 19 percent over the 12,153 drilled in the same period of 1947. Just how long the current drilling program can hold this large lead remains to be seen. It will be determined by the supplies of tubular goods, which remain scarce and show few signs of easing.

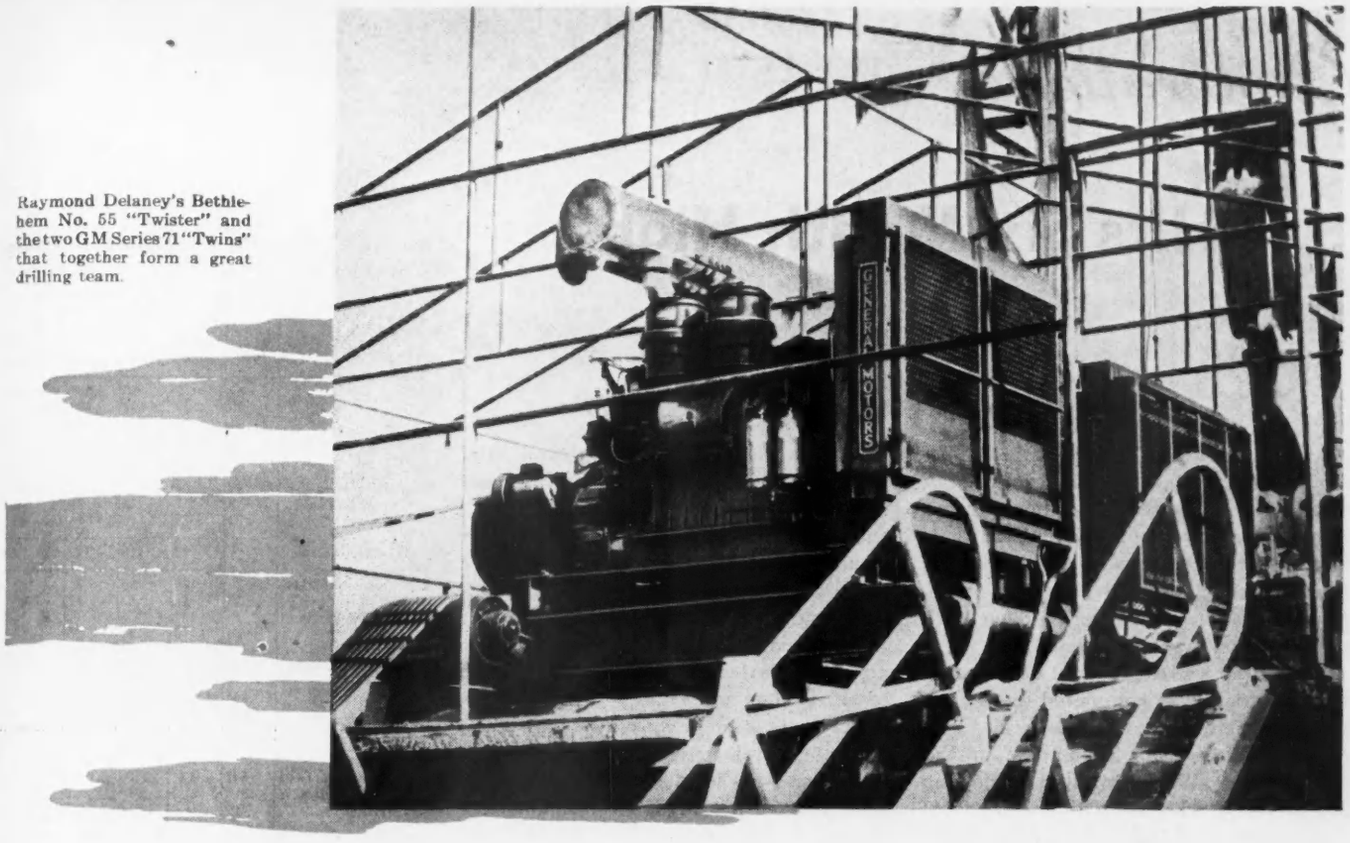
While the number of active drilling rigs in Texas and Oklahoma at the end of May showed little change from the count a month earlier, the number of wells completed during the month declined considerably. Texas completed 917 while 1117 were finaled during April, a drop of 200 wells. Oklahoma's dropped from 388 a month ago to 337. Usually the U. S. total follows these two leaders, but such was not the case in May for the grand total showed a decrease of only 16 wells. The difference was made up by increased activity in Illinois, Kansas, and California. Illinois completed 238 wells during May to set the highest mark for that state since September, 1946. Illinois' April total was 128 wells. Part of the rise was due to the difficult operating conditions during the spring which delayed completion till May of many wells which, under favorable conditions, would have been completed earlier.

Kansas' wells climbed from 231 in April to 284, and California's increased from 185 to 213. Louisiana's records showed exactly the same number of wells in each of the two months, that being 200.

Well Completions in the United States During May, 1948, and Cumulative for Year.

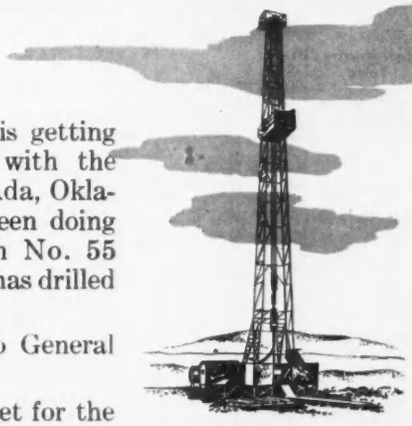
(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon, and Allegany fields of Pennsylvania and New York from The Producers' Monthly.)

STATE OR DISTRICT	MONTHLY COMPLETIONS, MAY, 1948 — NEW WELLS: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New	Total Drilled Deeper	TOTAL COMPLETIONS: May, 1948	April, 1948	May, 1947	Footage May, 1948	CUMULATIVE TOTAL: Wells 1948	Wells 1947	Percent Diff.	Footage 1948	Rigs in Operation (Drilling, Rigging Up and Shut Down): May 31, 1948	April 30, 1948	May 31, 1947
Alabama				1				1	1	2	2	1	5,201	6	7	— 14.3	29,561	4	3	6
Arizona																		7	7	2
Arkansas	15			7				22		22	27	30	88,733	114	101	+ 12.9	459,612	39	35	34
California	177		2	29				208	5	213	185	154	782,970	1,017	787	+ 29.2	3,595,310	280	276	267
Colorado	17		1					18		18	19	16	115,054	104	63	+ 65.1	583,517	54	58	47
Florida				2				2		2	2	3	17,046	10	13	— 23.1	70,010	4	4	6
Georgia														2	1	+100.0	8,871			1
Illinois	126		2	110				238		238	128	148	590,739	794	735	+ 8.0	1,997,321	253	242	215
Indiana	31			35				66		66	61	41	137,035	342	192	+ 78.1	631,967	106	100	64
Kansas	137		44	101			2	284		284	231	177	922,983	1,077	931	+ 15.7	3,544,375	285	284	304
Kentucky	29		23	16				68		68	51	77	134,261	280	298	— 6.0	571,910	84	75	123
Louisiana	122	10	9	57			2	200		200	200	114	882,111	808	507	+ 59.4	3,984,497	233	227	169
North Louisiana	94	1	7	34			1	137		137	124	63	354,818	512	264	+ 93.9	1,365,992	79	76	40
South Louisiana	28	9	2	23			1	63		63	76	51	527,293	296	243	+ 21.8	2,618,505	154	151	129
Maryland														1			5,259			
Michigan	15			37				52	1	53	44	67	119,871	246	209	+ 17.7	580,020	127	120	105
Mississippi	20	2		13				35	1	36	24	56	281,604	159	159		1,317,507	52	48	99
Missouri				5				5		5	9	4	1,783	26	23	+ 13.0	8,442	5	7	4
Montana	21		2	9				32		32	14	19	82,551	120	50	+140.0	310,778	48	49	64
Nebraska														1			4,965			6
Nevada																		1	1	
New Mexico	33		1	9				43		43	58	54	190,283	258	236	+ 9.3	1,046,870	130	110	122
New York	80			3	52			135		135	130	150	204,530	689	638	+ 8.0	1,011,406	168	171	180
North Carolina															1	—100.0				
Ohio	43		33	45				121	3	124	109	112	281,804	504	519	— 2.9	1,319,414	216	225	232
Oklahoma	184		19	128				331	6	337	388	257	1,204,311	1,585	1,454	+ 9.0	5,490,849	580	581	514
Oregon																				1
Pennsylvania	103		40	14	92	18		267	1	268	263	276	458,686	1,298	1,328	— 2.3	2,261,554	396	369	361
South Dakota											1			1			1,365			
Tennessee	1							1		1	4	2	1,923	15	8	+ 87.5	23,459	20	20	5
Texas	539	13	36	315	1	1	2	907	10	917	1,117	707	3,838,967	4,571	3,495	+ 30.8	19,461,589	1,446	1,458	1,218
Dist. 1—S. Central	15		1	17				33		33	49	23	109,263	203	127	+ 59.8	630,971	47	49	30
Dist. 2—Middle Gulf	39	3	2	24				68	2	70	83	45	407,344	328	248	+ 32.3	1,882,215	59	66	61
Dist. 3—Upper Gulf	45	3	3	36				87		87	103	69	575,523	405	326	+ 24.2	2,691,107	137	141	98
Dist. 4—L. Gulf-S.W.	48	5	6	52				111	4	115	124	97	560,945	545	442	+ 23.3	2,692,574	112	125	107
Dist. 5—E. Central	9		2	7				18		18	14	8	72,337	75	44	+ 70.5	367,929	35	32	16
Dist. 6—Northeast	7	2	6	5				20	1	21	30	33	123,252	149	185	— 19.5	822,795	51	55	69
Dist. 7-B—N. Central	42		5	51			1	99		99	120	60	326,793	511	312	+ 63.8	1,576,766	163	165	122
Dist. 7-C—W. Central	14			6				20		20	30	23	75,678	141	91	+ 54.9	529,807	88	78	67
Dist. 8—West	193		3	23				219	3	222	280	161	950,239	1,137	734	+ 54.9	5,129,642	490	495	364
Dist. 9—North	85			93	1	1	1	181		181	213	151	469,747	847	800	+ 5.9	2,394,118	104	109	168
Dist. 10—Panhandle	42		8	1				51		51	71	37	167,846	230	186	+ 23.7	733,665	160	143	116
Utah			1					1		1	2	1	12,146	9	3	+200.0	43,210	10	9	4
Virginia														1			2,301			
Washington											1			1			6,278	1	1	1
West Virginia	8		39	14		1		62	1	63	69	51	162,322	314	312	+ 0.6	790,670	378	390	369
Wyoming	20			17				37	5	42	37	18	167,620	163	83	+ 96.4	670,165	140	119	80
Total U. S.	1,721	25	252	967	145	20	6	3,136	34	3,170	3,186	2,535	10,684,634	14,516	12,153	+ 19.4	49,833,052	5,067	4,989	4,603



Raymond Delaney's Bethlehem No. 55 "Twister" and the two GM Series 71 "Twins" that together form a great drilling team.

Every Job A Fast Drilling Record



DRILLING wells in fast time is getting to be a profitable habit with the Delaney Drilling Company of Ada, Oklahoma. Raymond Delaney has been doing just this with his Bethlehem No. 55 "Twister" rig on all the wells he has drilled so far.

The rig is powered with two General Motors "Twin" Diesels.

Right there is part of the secret for the success. For, you see, these engines deliver great quantities of quick-stepping power, yet fit in compact space. They snap into action and pull out a string of drill pipe as fast as the crew can handle the pipe. They hum along on their job steadily with great economy of fuel and with the minimum of maintenance. Then when the job's done, away they go right with the unit—because these engines fit within road width.

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Power Equipment, Inc. WICHITA, KANSAS	United Tool & Valve Repair Co. SHREVEPORT, LOUISIANA	Seitz Machinery Company, Inc. BILLINGS, MONTANA	Stewart & Stevenson Services, Inc. HOUSTON 11, TEXAS	Gehring Equipment Co. CASPER, WYOMING

Exploration

Hits Six-Month High

A NEW six-month high in exploratory well completions was set in May when 542 tests searching for new sources of oil and gas were completed. Not since October of last year when 609 such wells were finaled have they reached that high. In April, a month earlier, 516 wells in that category were completed.

Attracting a great amount of attention were two wildcats completed during the month. One of these was Pure Oil Company's West Poison Spider test in Natrona County, Wyo., brought in flowing 900 barrels of 43-gravity oil per day from a total depth of 14,307 feet to lay claim to the world's deepest producer title. The other was a discovery of apparent major proportions made by Midcontinent Petroleum Corporation in Lea County, New Mexico. The well, Sawyer 1, produced initially 3744 barrels of 42-gravity oil per day from 12,115-215 feet in Devonian sands and has resulted in considerable leasing activity and a rush to start offset wells.

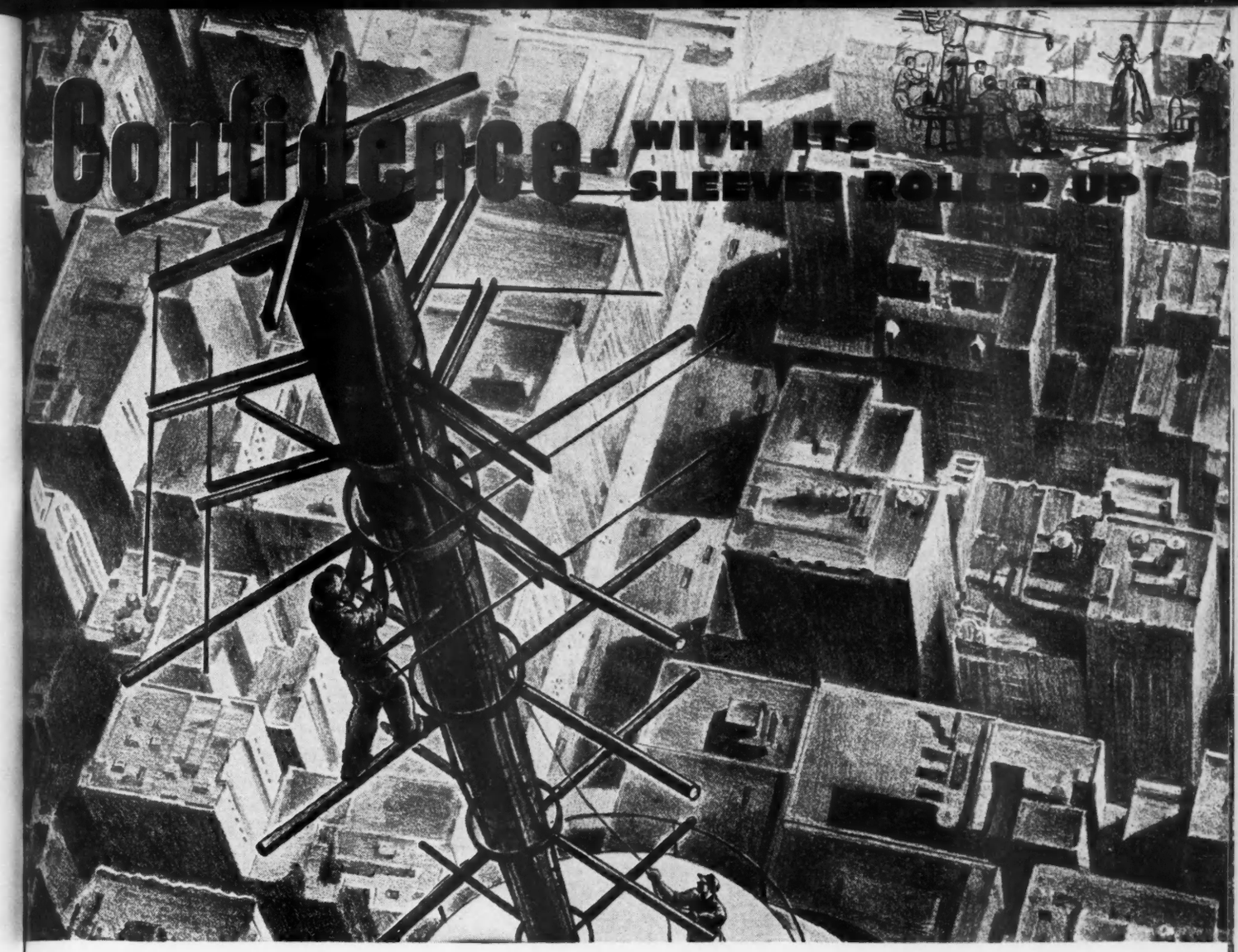
May's new high brought the year's five-month total to 2425 completed exploratory wells for a 25 percent lead over last year, when 1930 tests had been drilled by this time. Even though the

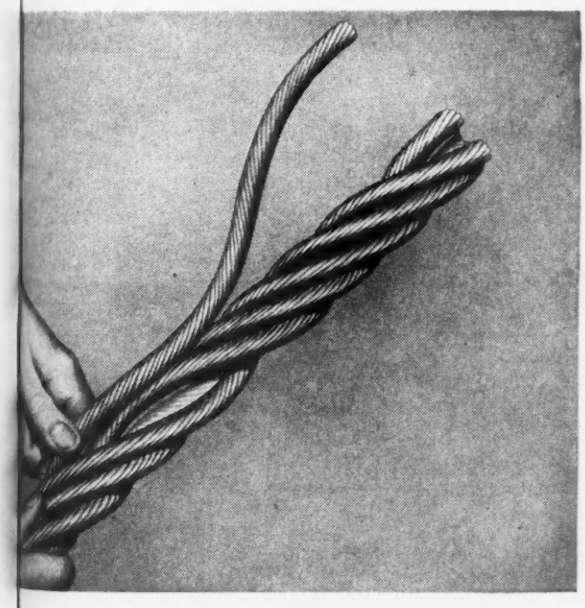
Summary of Results of Exploratory Drilling

ITEM	May 1948	April 1948	FIVE MONTHS: JAN.-MAY 1948	1947	Percent Diff.
Oil Discoveries	67	75	325	270	+ 20.4
New Fields	43	40	194	154	+ 26.0
New Pays	24	35	131	116	+ 12.9
Distillate Discoveries	9	6	38	38	.....
New Fields	7	3	18	17	+ 5.9
New Pays	2	3	20	21	— 4.8
Gas Discoveries	10	11	52	39	+ 22.0
New Fields	9	7	36	28	+ 28.6
New Pays	1	4	16	11	+ 45.5
Total Discoveries	86	92	415	347	+ 19.6
Extensions to Fields	27	20	80	56	+ 42.9
Oil Fields	19	16	63	43	+ 46.5
Distillate Fields	.....	1	6	7	— 14.3
Gas Fields	4	3	11	6	+ 83.3
Total Prod. Tests	109	112	495	407	+ 22.8
Dry Holes	433	401	1930	1527	+ 26.4
Wildcats	425	397	1895	1476	+ 28.4
New Pays	1	.....	6	25	— 76.0
Outposts	7	7	29	26	+ 11.5
Total Exploratory Tests	542	516	2425	1930	+ 25.6
Percent Productive	20.1	21.7	20.4	20.9	.....
Percent Dry	79.9	78.3	79.6	79.1	.....

Results of Exploratory Drilling in May and First 5 Months, 1948-1947, By Districts

State or District	MONTH OF MAY, 1948													FIRST FIVE MONTHS, 1948																
	Productive Tests									Unproductive Tests			Total Exploratory Tests	Productive Tests								Unproductive Tests					Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive	Wildcats	New Pays	Outposts		New Fields			New Pays			Extensions			Total Productive		Wildcats	New Pays	Outposts	Total Dry		
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas						Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	1948	1947				5 Mo. 1948	5 Mo. 1947	5 Mo. 1948	5 Mo. 1947
Alabama	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	.....	.....	6	5	6	5
Arkansas	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	.....	.....	5	2	.....	.....	.....	.....	.....	.....	.....	.....	2	4	32	.....	.....	32	25	34	29
California	.....	.....	1	3	.....	.....	6	.....	1	11	15	.....	.....	26	4	.....	1	6	.....	.....	9	1	1	22	8	85	.....	.....	85	104	107	112
Colorado	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	18	.....	.....	18	14	18	16
Florida	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	.....	.....	7	12	7	12
Georgia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	2	1	2	1
Illinois	4	.....	.....	1	.....	.....	5	.....	.....	10	43	.....	.....	53	9	.....	.....	11	.....	.....	13	.....	.....	33	46	163	.....	.....	163	137	196	183
Indiana	1	.....	.....	.....	.....	.....	1	.....	.....	2	19	.....	.....	21	5	.....	1	3	.....	.....	1	.....	.....	10	9	71	.....	.....	71	35	81	44
Kansas	6	.....	1	.....	.....	.....	.....	.....	.....	7	44	.....	.....	51	27	.....	1	2	.....	.....	1	.....	.....	31	29	168	1	.....	169	117	200	146
Kentucky	.....	.....	.....	1	.....	.....	.....	.....	.....	1	7	.....	.....	8	1	.....	.....	1	.....	.....	1	.....	.....	4	4	17	.....	.....	17	27	21	31
Louisiana	.....	3	1	7	1	1	1	.....	.....	14	16	.....	.....	30	2	5	2	21	6	1	2	3	.....	42	34	85	.....	1	86	83	128	117
North Louisiana	.....	.....	1	.....	.....	.....	1	.....	.....	2	8	.....	.....	10	1	.....	1	1	.....	.....	2	2	.....	7	5	41	.....	.....	41	46	48	51
South Louisiana	.....	3	.....	7	1	1	.....	.....	.....	12	8	.....	.....	20	1	5	1	20	6	1	.....	1	.....	35	29	44	.....	1	45	37	80	66
Maryland	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1	.....
Michigan	1	.....	.....	.....	.....	.....	.....	.....	.....	1	20	.....	.....	21	4	.....	3	.....	.....	.....	1	.....	.....	8	7	92	.....	.....	92	76	100	83
Mississippi	.....	.....	.....	.....	.....	.....	1	.....	.....	1	9	.....	.....	10	.....	.....	.....	.....	.....	.....	2	.....	.....	2	5	36	.....	.....	36	26	38	31
Missouri	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	3	7	3	7
Montana	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	2	1	.....	.....	.....	.....	.....	1	.....	.....	2	1	13	.....	.....	13	5	15	6
New Mexico	2	.....	.....	.....	.....	.....	.....	.....	.....	2	4	.....	.....	6	6	1	.....	3	.....	1	.....	.....	.....	11	5	26	.....	.....	26	23	37	28
North Carolina	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1
Ohio	.....	.....	.....	.....	.....	.....	1	.....	1	2	2	.....	.....	4	1	.....	.....	.....	.....	.....	1	.....	7	9	1	15	.....	.....	15	23	24	24
Oklahoma	4	.....	2	2	.....	.....	1	.....	.....	9	36	.....	.....	45	20	2	7	13	.....	.....	3	.....	.....	45	43	181	.....	1	182	227	227	270
Pennsylvania	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	2	.....	2	.....
S. Dakota	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1	.....
Tennessee	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	9	.....	.....	9	8	10	8
Texas	21	4	2	10	1	.....	3	.....	2	43	189	1	7	240	106	10	15	63	14	14	26	2	3	253	198	834	5	26	865	550	1118	748
Dist. 1 S. Central	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	.....	.....	15	1	.....	.....	1	.....	1	.....	.....	.....	3	4	75	.....	.....	75	56	78	56
Dist. 2 Middle Gulf	2	.....	1	2	.....	.....	1	.....	.....	6	16	.....	.....	22	9	1	2	9	6	2	3	1	.....	33	23	80	1	5	86	45	119	68
Dist. 3 Upper Gulf	1	1	.....	6	.....	.....	.....	.....	2	10	22	1	.....	34	6	3	.....	21	2	2	3	1	2	40	36	102	1	2	106	60	146	96
Dist. 4 L. Gulf-S.W.	3	2	1	.....	1	.....	.....	.....	.....	7	32	.....	4	43	9	4	3	8	6	9	1	.....	.....	40	47	132	1	11	144	92	184	139
Dist. 5 E. Central	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	.....	.....	7	2	.....	.....	2	.....	.....	1	.....	.....	5	3	20	.....	.....	29	24	34	27
Dist. 6 Northeast	1	1	.....	.....	.....	.....	.....	.....	.....	2	3	.....	.....	5	1	2	.....	4	.....	.....	4	.....	.....	11	3	30	1	.....	31	24	42	27
Dist. 7-B N. Central	4	.....	.....	.....	.....	.....	.....	.....	.....	4	34	.....	.....	38	32	.....	7	9	.....	.....	1	.....	.....	49	31	144	.....	.....	144	94	193	125
Dist. 7-C W. Cent.	.....	.....	.....	.....	.....	.....	1	.....	.....	1	5	.....	.....	6	6	.....	.....	1	.....	.....	1	.....	.....	8	6	32	.....	.....	32	11	40	17
Dist. 8 West	6	.....	.....	1	.....	.....	1	.....	.....	8	14	.....	.....	22	19	.....	2	3	.....	.....	6	.....	1	31	16	64	1	4	69	50	100	66
Dist. 9 North	4	.....	.....	1	.....	.....	.....	.....	.....	5	40	.....	3	48	21	.....	1	5	.....	.....	6	.....	.....	33	27	143	.....	4	147	94	180	121
Dist. 10 Panhandle	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	2	.....	.....	2	4	2	6
Utah	.....	.....	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....	1	.....	8	.....	.....	8	3	9	3
Virginia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1	.....
Washington	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1	.....
West Virginia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	2	1	.....	.....	.....	.....	.....	2	1
Wyoming	3	.....	1	.....	.....	.....	.....	.....	.....	4	7	.....	.....	11	5	.....	1	8	.....	.....	2	.....	.....	16	6	19	.....	1	20	18	36	24
Total U.S.	42	7	9	24	2	1	19	.....	4	109	425	1	7	542	194	18	36	131	20	16	63	6	11	495	407	1895	6	29	1930	1527	2425	1930





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two years are somewhat apart in the total number of tests drilled, the success ratio of the periods are very close. So far in 1948, 20.4 percent of the total have been completed as successful while a year ago producers amounted to 20.9 percent. In other words one out of every five exploratory wells drilled found production of some kind and quantity. These, of course, range from discoveries of areas that will prove to be of major importance to marginal wells which, although they are rated now as discoveries, may die early deaths or may never prove to be anything but one- or two-well fields. Regardless of the financial risks with these large dry-hole odds, the wildcatters are continuing to step up operations.

Spurring this exploration on are current crude oil prices, and retarding it on the other hand is the scarcity of steel pipe. Some companies are reported to be buying sheet steel wherever and whenever they can and having it rolled and welded into casing. This is a costly procedure, but justifiable in these days of shortages and increased demands for oil. Extreme measures of this kind increase the financial hazards of this already risky business, but oil is needed and the needs are increasing.

The last general crude price hike occurred in the latter part of 1947 and since that time oil production has been pushed to new all-time peaks. Another price increase seems very probable for the near future, as bonus payments are becoming more frequent as well as larger. These are fairly reliable signs of a price increase. There is little reason to believe that increased chances for profit would not prove an added incentive for the oil industry, which is noted for its risk-taking and resourcefulness in seeking out and producing additional oil.

Paper Work Reduced

■ CONTINUED FROM PAGE 54

and foreign operations received a 40 percent greater volume of material, equipment and services during 1947 than for any previous year. The total dollar value of all invoices clearing through the purchasing department increased 76 percent in 1947 over 1946; yet paper work in the field was reduced considerably. Beginning in 1946, when the orderly requisitioning procedure was put into effect by the company's refining department, the value of individual requisitions during the last three quarters of 1946 increased 45 percent over the preceding quarter, but considerable paper work was eliminated.

Plans have materialized which will enable field requisitioning points of the company's sales department to issue release orders against blanket orders or contracts direct on the supplier with no more effort than heretofore was used in the preparation of material requisitions on the purchasing department, and this will reflect in an appreciable savings of time in the procedure of repair parts, for gasoline pumps, compressors, lifts; etc., as well as eliminate duplication of work by the purchasing department. As prices and terms are established by the purchasing department, and invoices continue to be approved by the purchasing department, it is not felt that any control of procurement of this type of material will be sacrificed.

To reflect true conditions of material availability—which varies geographically—the divisional purchasing agent will outline to the requisitioning points he serves the conditions that prevail in his particular area.

It is interesting to note detailed figures as to the reduction in the "paper work" burden for this company on the basis of its experiment so far. While the total dollar volume of purchases through the purchasing department increased 76.40 percent in 1947 over 1946, this involved an actual average increase in the "paper work" load of only 14.89 percent. A further breakdown of this "paper work" load reveals that the number of requisitions received increased 12.57 percent, whereas the purchase orders issued increased only 4.51 percent. Furthermore, the invoices verified increased 20.80 percent.

Percentagewise, the minimum increase in the "paper work" load appeared as expected in purchase orders issued, whereas the maximum increase was under the category of "invoices verified."

As a result of these findings it was decided to investigate further the maximum increase in the number of invoices verified. A survey was made of the fourth quarter 1947 activities, and this disclosed that of a total of 110,911 invoices verified, 48,295, or 43.54 percent, were for $25 or less, with an average aggregate value of only 1.19 percent of the total dollar volume of the purchases. The majority of invoices for $25 or less relate to repair parts and small maintenance items for the sales and producing departments.

Some means is being sought to reduce this class of invoices. The company is exploring the suggestion that one way to reduce the number of small invoices received as well as purchase orders issued would be for gasoline pump manufacturers to design a standard, preprinted order blank for use by consignees, service station operators; etc., in obtaining their repair parts. Such a preprinted order could have a relief drawing the pump cut away to show repair parts involved. With this information the operator could order his requirements direct from the manufacturer, thus reducing the number of invoices involved and entirely eliminating the necessity for requisitions on the purchasing department as well as the purchase order subsequently issued.

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in May, 1948
Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		CALIFORNIA—New Oil Pays						
Kern	Coles Levee	Richfield Oil Corp's Cole Levee A 21-33 (OWWO), 990 s 330 s fr nwc Sect 33-30s-25e.	5-17-48	10025	8900 -9100	L. Western Zone; Mio	F 498	33.6
Kern	Maricopa	Standard Oil Co's 9K-54, 2310 s, 330e fr n¼ cor, Sect 9-11n-23w	4-27-48	5300	4985- 5148		P 61	31.5
Kern	McDonald Anticline	Independent Exploration Co's Layman 2, 660 s 1320 e fr w¼ cor Sect 18-28s-20e.	5-17-48	1620	1372- 1404	Devil-Water-Gould sd; Plio	P 25	25
		CALIFORNIA—Oil Field Extensions						
Kern	Mount Poso	Aga Oil Co's Fee 13, 2520 s 600 e fr n¼ cor, Sect 3-27-s-28e, se extension	5-15-48	1398	1334- 1398	Vedder sd; Mio	P 35	15
Kern	Paloma	Chanslor-Canfield-Midway Oil Co's Fee 23-35, 990 n 990 e fr w¼ cor, Sect 35-31s-26e, n extension.	5-10-48	11740	11600-11738	Paloma sd; Mio	F 187; 1/4"	30
Kern	Palmoa, NW.	Ohio Oil Co's KCL-B 41-30, 334 s 338w fr n¼ cor, Sect 30-31s-26e	5- 3-48	11167	10842-	Paloma sd; Mio	F 400; 1/2"	49.8
Kern	Paloma, NW.	Richfield Oil Corp's M&L 78-24, 330 n 990 w fr se cor Sect 24-31s-25e, ½ mi nw extension.	5- 9-48	11335	11206-11330	Palmoa sd; Mio	F 720; ½"	42
Orange	Brea-Olinda	Shell Oil Co's Puente-Orange 1, 153 s 4.44 w fr ne cor Sect 3-3s-10w, w extension.	5-12-48	5375			P 213	
Sonoma	Petaluma	Trico O&G Co's Petaluma Comm 5-2, 620 s 600w fr ne cor, Sect. 30-5n-6w	4-24-48	971	946- 971		P 32	19.7
		CALIFORNIA—New Gas Field						
Monterrey		Jergins Oil & North American Cons. Oil Co's Orradre 1, 1400 n 950 e fr sw cor Sect 12-23s-10e, 3½ mi se San Ardo fld.	5-19-48	2225	2130- 2225		7.5 mln, 11/16"	

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inche

From a profit-making standpoint, there are few units in the oil field that compare with the "Cardwell" Mobilhoist. Every kind of servicing job can be handled with this fast operating rig, plus rotary or cable tool workover jobs. Drums have five even-step speeds and one reverse to provide a wide range of speeds. The Mobilhoist is available with Waukesha MZA, and "Caterpillar" D318 engines, and is recommended for well servicing to 4,000 feet; 2,000-foot drilling with 3½-inch drill pipe, or cable tools to 3,800 feet. Write for descriptive folder, or see your nearest "Cardwell" representative.

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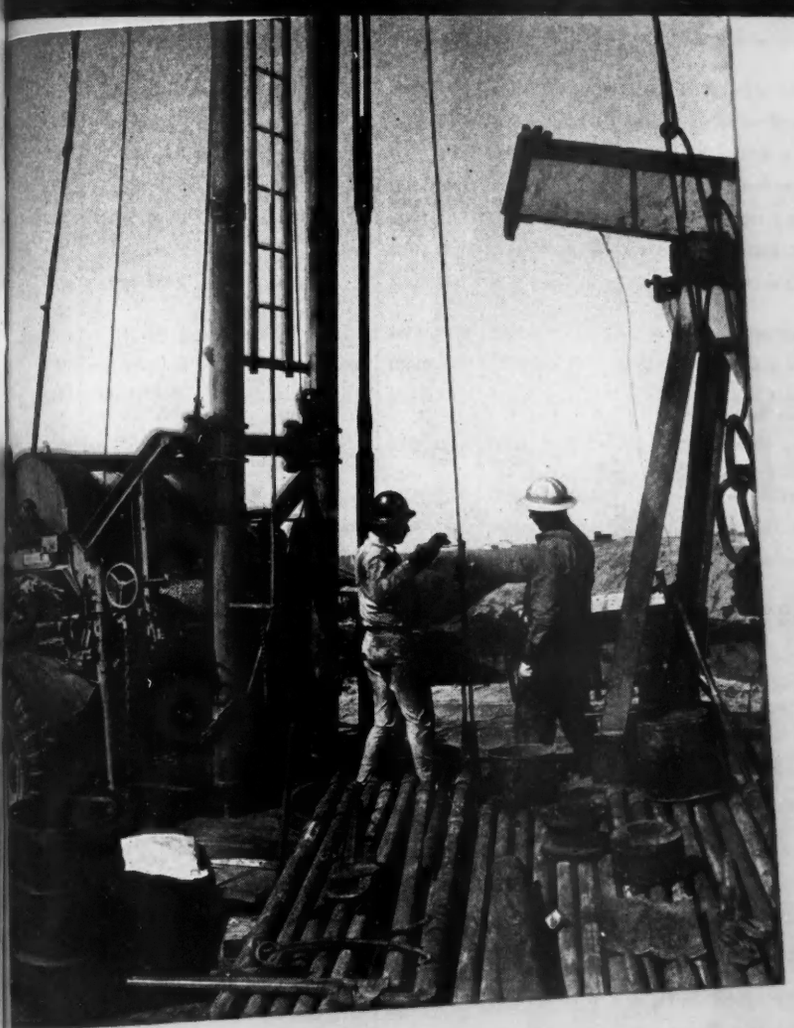

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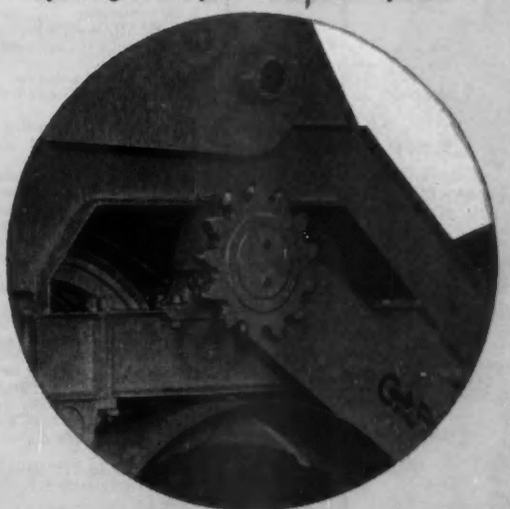
Spudding assembly for all cable tool operations.



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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in May, 1948—Continued

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		CALIFORNIA—Gas Field Extension						
Sacramento	Rio Vista	D. D. Feldman's Gardiner 1, 1400 s 300 w fr ne cor Sect 35-4n-3e, 1½ mi e extension.	5-22-48	4645	4494- 4511	Capay sd; Eoc	3 mln	
		ILLINOIS—New Oil Fields						
Clay	Sailor Springs, W.	Diamond Exploration Co's Toliver-Woods Comm 1, ne sw nw 15-4n-7e, 1½ mi sw Bible Grove Cons. pl.	5- 4-48	2620	2611- 2616	Cypress sd; Miss	P 56	
Lawrence	Lancaster, N.	J. S. Young Jr's Frick & Limp 1, se sw ne 24-2n-13w, 3 mi nw Lancaster pl.	5-18-48	2534	2294- 2307	Bethel sd; Miss	P 5	
Richland	Passport, S.	Arvin Drlg Co's A. McDade 1, se nw sw 17-4n-9e, ¾ mi s Passport pl.	5-18-48	2682	2667- 2682	Cypress sd; Miss	P 23	
White	Sumpter, S.	W. O. Allen's Hughes 1, se sw nw 2-5s-9e, 1½ mi s Sumpter	5- 4-48	2611	2576- 2582	Waltersburg sd; Miss	P 25	
		ILLINOIS—New Oil Pay						
White	Grayville, W.	R. Mitchell's Hatcher 1, se ne se 22-3s-10e	5- 4-48	3305	1960- 1966	Biehl sd; Penn	P 42; 140 wtr	
		ILLINOIS—Oil Field Extensions						
Clay	Passport	J. Bander et al's W. Phillips 1, ne ne se 14-4n-8e, ½ mi sw extension	5-25-48	3041	3011- 3037	McClosky li; Miss	P 240	
Clay	Clay City-Noble Consol.	R. Johnson et al's F. Blessing 1, ne se nw 22-3n-8e, ¾ mi extension	5-25-48	3037	2926- 2938 2985- 3020	Aux Vases sd; Miss Rosiclare li; Miss	P 9; 24 wtr	
Edwards	Ellery, N.	B. Lambert et al's M. Broster 1, se ne sw 7-2s-10e, ½ mi sw extension	5- 4-48	3391	3321- 3333	Rosiclare li; Miss	P 12	
Hamilton	Rural Hill	Gulf Oil Corp's Lightner 1, ne nw ne 3-7s-5e, ½ mi sw extension	5-30-48	3529	3311- 3325	Aux Vases sd; Miss	P 170; 40 wtr	
Wabash	Maud, N.	C. E. Skiles' W. Smith 1, ne nw ne 20-1s-13w, ½ mi s extension	5-25-48	2589	2576- 2589	Bethel sd; Miss	P 140	
		INDIANA—New Oil Field						
Gibson		A. E. Morrison Tr's Henry Haper Heirs 1, 330 fr n&wl nw nw nw Sect 34-1s-10w, Patoka Twp.	5-21-48	2030	2027- 2030	McClosky li; Miss	P 20	
		INDIANA—Oil Field Extension						
Vanderburgh	Vernon Hts.	Geo. S. Engle's Geo. E. Schmidt 1, nw ne se 6-7s-11w, ½ mi s extension	5-31-48	2533	2526- 2533	McClosky li; Miss	P 190	
		KANSAS—New Oil Fields						
Barber	De Geer	Lion Oil Co's De Geer 1, ne ne sw 2-33s-15w, 1¼ mi s Deerhead pl.	5-25-48	5434	5176- 5178	Viola li; Ord	F 3000; 12/64"	41
Barton	Klug, N.	Stickle Drlg & Harwood Oil Co's Child 1, sw sw nw 27-17s-13w, betw Hoisington & Klug pls.	5-11-48	3381	3377- 3380	Arbuckle li; Ord	P 90	
Reno	Albion	Helmerich & Payne's Stucky 1, sw sw sw 14-26s-6w, 10 mi w Hilger pl.	5-18-48	4200	3648- 3664	Mississippi li; Miss	F 51	
Rooks	Berland	The Texas Co's Berland 1, ne se sw 19-10s-19w, 3 mi e Marcotte pl.	5-18-48	3807	3803- 3807	Arbuckle li; Ord	P 160; 6 wtr	
Sedgwick	Fairview	J. P. Gaty's Phillips 1, ne nw se 8-26s-2e, 2 mi nw Greenwich pl.	5- 5-48	2961	2960- 2961	Mississippi li; Miss	P 1173	44
Sedgwick	Chambers	Lee Wentworth et al's Chambers 1, se se se 10-29s-2w, 1 mi n Clearwater pl.	5-18-48	3550	3546- 3550	Conglomerate; Penn.	P 25; 3 wtr	44.4
		KANSAS—New Gas Field						
McPherson		Don T. Ingling's Griffith 1, sw sw sw 33-19s-1w, 1 mi fr Ritz-Canton fld.	5-25-48	3008	2985- 3008	Mississippi li; Miss	0.8 mln	
		KENTUCKY—New Oil Pay						
Henderson		Carter Oil Co's A. E. Melton 1, 14-0-23, area betw Robards & Dixie	5-14-48	2710	1754- 1766	Waltersburg sd; U. Miss	P 196	
		NORTH LOUISIANA—Oil Field Extension						
Madison	Delhi	Kingwood Oil Co's J. M. Frazier A-2, 667 fr nl 472 fr wl Sect 15-17n-10e, 1 mi e extension.	5- 5-48	3369	3364- 3366	Paluxy sd; L. Cre	F 237; 4/64"	40.7
		NORTH LOUISIANA—New Gas Field						
De Soto		The Texas Co's J. J. Rambin et al 1, 1962 fr wl 1980 fr nl Sect 23-11n-11w	5- 4-48	8082	4972- 4996	Rodessa sd; L. Cre	0.5 mln; 4/64"	
		SOUTH LOUISIANA—New Oil Pays						
Beauregard	Oretta	Magnolia Pet Co's Hollins-Mayer 2, 660 s 600 w of nec of ne¼, nw¼ Sect 32-6s-11w.	5-14-48	4466	4403- 4415		F 32; 24/64"	26.8
Beauregard	Hurricane Creek	Magnolia Pet Co's Doornbos-McPherson 1, 760 n 2030 w of sec Sect 26-5s-8w.	4-24-48	9100	8234- 8237		F 72; 4/64"	48
Cameron	Mud Lake, E.	Magnolia Pet Co's Lutcher C-3, 2640 s 423 e of nwc Sect 24-14s-11w.	5-20-48	11913	11340-11360		F 298; 24/64"	36.2
Iberia	Weeks Island	Humble O&R Co's R. H. Goodrich 3, 778 s 188 w of No. 2 well, Twp 14s-6e	5-16-48	8922	8874- 8904		F 292; 20/64"	34
LaFourche	Delta Farms	The California Co's Delta Farms Lse 1-14, 2508 e 1402 s fr nwc Sect 6-17s-23e.	5- 2-48	12888	11811-11819		F 240; 1/8"	26.5
St. Martin	Lake Mongoulois	The Texas Co's State-Lake Mongoulois Lse 303-S, 4949 n 1041 e of swc of Frac Sect 10 in Sect 4-10s-9e.	5-16-48	11093	10968-11008		F 209; 4/64"	25.8
St. Martin	Sect. 28 Dome	Shell Oil Co's St. Martin Land Co. Unit B-2, 2212 w 1433 n of sec Sect 29-9s-7e.	5- 3-48	5184	4841- 4845		F 130; 1/8"	26.1
		SOUTH LOUISIANA—New Distillate Fields						
Jefferson	"Little Lake"	Gulf Ref Co's LLE A-1, 750 e alz nl Sect 5-18s-23e, fr nwc th 660 s at ra to line.	5-18-48	12072	9889- 9894		F 142; 4/64"	
Plaquemines	"Pointe a la Hache"	S. W. Richardson's Delacroix Corp E-4, 2044.27 e of wl 50 at ra fr sl of Sect 34-16s-14e.	5-11-48	11313	10196-10207		F 44; 4.4 mln; 4/64"	53.8
St. Mary		The Texas Co's State-Cote Blanche Island Lse 340-12, s 55 deg 30 min w 5850 fr USCGS Mon. "BLUFF" in West Cote Blanche Bay, Twp 15s-7e.	5- 1-48	13824	13300-13358		F 6; 7.7 mln; 20/64"	56.8
		SOUTH LOUISIANA—New Distillate Pay						
Terrebonne	Vour Isle Dome	Superior Oil Co's LLE-State Unit 12-3, 2849.24 s 2294 e of nwc Sect 24-21s-16e.	5- 4-48	11504	9950- 9965		F 167; 8.9 mln; 44/64"	49.1
		SOUTH LOUISIANA—New Gas Pay						
LaFourche	Raceland	Clifford H. Brown's Mrs. Ellis Dupuy et al A-1, Sect 35-15s-19e	4-22-48	4458	4371- 4391		1.4 mln; 4/64"	
		MICHIGAN—New Oil Field						
Allegan		Eric P. Schelling's Barnhardt 1, sw ne ne 30-3n-12w, Hopkins Twp.	5-14-48	1539	1537- 1539	Traverse li; Devo	P 350	
		MISSISSIPPI—Oil Field Extension						
Lincoln	Mallalieu	Lion Oil Co's O. C. Grenn 1, 330 s 330 e of nwc, nw sw Sect 20-6n-8e, ½ mi s extension.	5-14-48	10480	1045-10464	Massive sd; L. Cre	F 723; 4/64"	
		NEW MEXICO—New Oil Fields						
Lea	Cross Roads	Mid-Continent Pet Corp's Sayer 1, 660 fr sl 1980 fr el Sect 27-9s-36e	5-11-48	12258	12115-12215	Devonian	F 3744; ¾"	42.6
Lea		Barney Cockburn's Corbin 1 (OWWO), 660 fr n&el Sect 4-18s-33e	5-15-48	5257	4049- 4054		P 10	
		OHIO—Oil Field Extension						
Morgan	Malta	National Gas & Oil Corp's J. C. O. Tompkins 1, ne ne 36, Penn Twp, 4 mi s Malta	5-17-48	4934	4926- 4932	Medina sd; Sil	Sw 5	
		OHIO—Gas Field Extension						
Medina	Medina-Summit	Ohio Fuel Gas Co's A. M. McMichael 1, Lot 6, Litchfield Twp, 2 mi w Litchfield.	5-20-48	2714	2662- 2667	Clinton sd; Sil	0.5 mln	
		OKLAHOMA—New Oil Fields						
Logan	Evansville, E.	Jordan Pet Co's Faver 1, se se se 8-15n-1e	5-20-48	5018	5010- 5018	Bartlesville sd; Penn	F 102	43
Hughes		Thomas N. Berry & Co's Hampton "B" 1, ne se nw 20-8n-10e	5-20-48	3140	3120- 3140	Cromwell sd; Penn	P 49; ¼"	
Lincoln		Falcon-Seaboard Oil Co's Edw. Bierman 1, ne nw ne 30-13n-5e	5-20-48	4996	4984- 4996	1st Wilcox sd; Ord	P 235	33
Lincoln		Anderson-Prichard Oil Co's Cunningham 1, ne sw nw 22-14n-4e	5-27-48	5024	5018- 5024	Wilcox sd; Ord	P 16; 296 wtr	40
		OHLAHOMA—New Oil Pays						
Noble	Polo, SE	Derby Oil Co's Albright 2, ne se ne 2-21n-2w	5-27-48	5157	4814- 4835	Mississippi li; Miss	P 11; 13 wtr	
Okfuskee	Carey	Gulf Coast Western et al's Ball 1, se nw sw, 27-12n-10e	5-20-48	2968	2938- 2968	L. Gilcrease sd; Penn	F 336; ¼"	
		OKLAHOMA—Oil Field Extension						
Stephens	Velma	Gulf & Stanolind O&G Co's Okla-Nat'l Unit 1, se se nw 32-1s-4w	5-20-48	6318	5948- 6086	Pennsylvania sd; Penn	F 689; ¾"	28.2
		OKLAHOMA—New Gas Fields						
Kay		Carter Oil Co's School Land-Kildare 1, se se se 13-27n-1e, Garrett dist.	5-27-48	4153	3494- 3502	Skinner sd; Penn	8.5 mln	
Pontotoc		J. C. Jacques' Meyers 1, se sw se 9-5n-6e	5-27-48	1758	1666- 1673	Senora sd; Penn	6 mln	
		TEXAS—District 2 (MIDDLE GULF COAST)—New Oil Fields						
Bee	Blanconia, S.	S. R. Chamberlain's H. C. Wood 1 (OWWO), 467 fr n&el of 200-ac lse, Jose Maria Castillo Sur, 10 mi w Refugio.	5-21-48	5318	5239- 5245	Vicksburg sd; Olig	F 99; 4/64"	30.6
Goliad	Gottschalt	W. L. Goldston et al's August F. Gottschalt 1, 467 fr w&nl of Tr, 2⅓ mi w-sw Weser fld.	5-13-48	8100	7606- 7612 7676- 7682	Luling sd; Eoc Mackhank sd; Eoc	F 8 mln; open F 138; 1/8"	cond 34.7
		TEXAS—District 2 (MIDDLE GULF COAST)—New Oil Pays						
Goliad	La Bahia	Overton Refg Co Inc's S. E. Cole 1, 500 fr wl 250 fr sl Blk 33, Rge 4 Goliad Town Tr.	5-14-48	5566	5550- 5566		F 4; ¼"	41.7
Jackson	Lolita-Deep	Humble O&R Co's Four-Way Ranch D-3, 330 fr s&el of Blk 160, 1st Reg Subd of La Ward Farms in I&GN Sur.	5- 2-48	8020	7556- 7564		F 134; 1/8"	44

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

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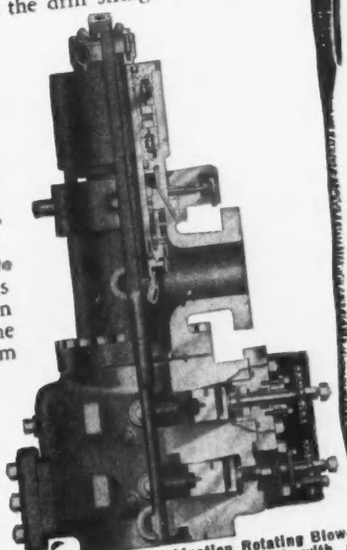
The Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper combines in *one* unit every necessary feature for complete and foolproof pressure control while drilling under pressure. Maintains continuous leakproof seal around all elements in the drill string whether square, hexagonal, octagonal or round . . . and (except for such abnormally large tools as reamers and bits) the seal expands and contracts *automatically* to fit varying diameters in the string.

The unit not only maintains its seal while the drill string is rotating, but also while pipe is being stripped in or out of the well. There is nothing as complete, as advanced, as simple as this Shaffer unit!

The Shaffer Double Cellar Control Gate contains *two* complete ram compartments unitized into *one* body. The ram assembly in the upper compartment closes around the drill string when pipe is in the well, the ram assembly in the lower compartment closes off open hole when pipe is out of the well. Even in largest sizes (for 13⅜" casing) overall height of the Double Gate is *less than 29"*—smaller sizes even more compact.

For applications where maximum conservation of vertical space is not essential, Shaffer also features a complete line of single Cellar Control Gates.



Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper (top) with a Shaffer Double Cellar Control Gate.

All Shaffer Cellar Control Gates are not only unusually compact, but are simple to install . . . are readily adaptable to any type of power drive—air, hydraulic, electric or steam, as well as manual. They have rams that are easy and quick to change . . . are operated by dependable foolproof *mechanical* drive . . . and incorporate many other vital advantages.

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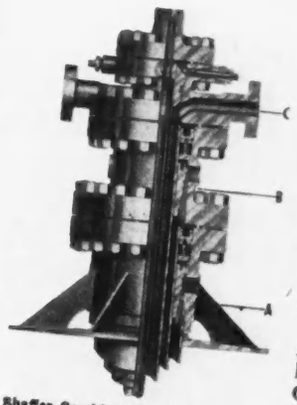


Shaffer Combination Landing Base Head, with Spool Type Landing Head and Shaffer Type 46 Tubing Head

Operators throughout the world depend on Shaffer for efficient, compact and completely modern casing suspensions and pack-offs.

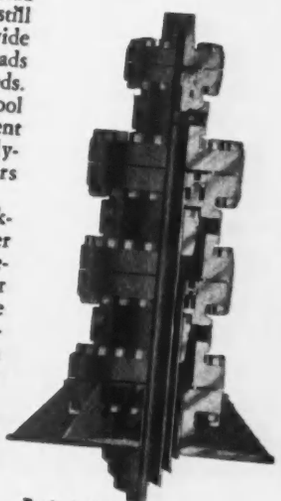
Shaffer Spool Type Landing Heads, the *pioneer* of this type of equipment, offer many unique advantages in simplicity of installation and maintenance. The Full-Opening design permits complete interchangeability of packing units to allow for change in casing sizes.

Where modern completion methods call for maximum installation compactness, the Shaffer Combination Landing Base Head (a) illustrated above is ideal. Although shown here with a Shaffer Spool Type Landing Head (b) and Shaffer Type 46 Tubing Head (c), where casing programs permit, the Spool Type Landing Head may be eliminated to provide still greater compactness. Also a wide selection of other Tubing Heads is available to meet varying needs.

The standard Shaffer Spool Type Landing Head arrangement shown below is another widely-used Shaffer design that offers many important advantages.

Five different types of packing units are available for Shaffer Heads to meet any completion requirement. In addition to regular types of packing assemblies, the Shaffer line also includes a recently-developed snap-ring type in which no threads are used in the internal bore of the Landing Head for holding the packing unit in place . . . and an all-metal packing unit for well conditions where this type of seal is desired.

The complete line of Shaffer Heads also includes special-purpose Casing Heads, a full line of Tubing Heads, Multiple Zone Hook-Ups, Bases and other similar equipment!



Typical Shaffer Spool Type Landing Head with regular type Landing Base and Shaffer Type 35 Tubing Head

Refer to pages 3843 to 3894 of your 1948 Composite Catalog for helpful information on the complete Shaffer line of pressure control equipment, fishing tools and other advanced oil tool products.

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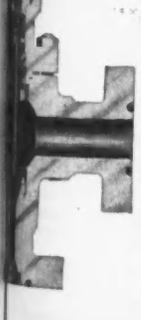
SHAFFER ADJUSTABLE FLOW BEANS



Still another important line of Shaffer pressure control equipment is Shaffer Adjustable Flow Beans—the ideal unit for regulating fluid flow on drilling wells, on production hook-ups, in refineries and wherever accurate control is desired.

Shaffer pioneered this type of equipment also, and offers the most complete line for every need—Conical Tips, Micro Tips, and electrically-heated Thermo Tips . . . regular and hard metal types . . . and in a full range of sizes from 1" through 4".

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in May, 1948—Continued

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		TEXAS—District 2 (MIDDLE GULF COAST)—Oil Field Extension.						
Gonzales	Arnim	Phillips Pet Co's Lilly Brown 1, 467 fr nl 330 fr wl 50-ac Lse, Adam Jumwalt Lge, ⅜ mi sw extension.	4-13-48	3230	2070- 2081	Carrizo-Wilcox sd; Eoc	F 16	.....
		TEXAS—District 2 (MIDDLE GULF COAST)—New Gas Field						
Lavaca	.....	Union Prod Co's Wm Borchers 1-A, 6062 fr el 467 fr sl of Wm Hosford Sur.	5- 1-48	11207	2030- 2040	.....	5 mln; open	.....
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Field						
Liberty	So. Liberty, SE	J. H. Woodard's Alexander Duessen 1, 3374 fr el 47.44 fr nl 24-ac Lse, David Minchey Sur.	5-18-48	6016	5022- 5030	.....	F 121.4; 1/2"	35.8
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Pays						
Galveston	Gillock, S.	Pan-American Prod Co's Eulies Nunez 1, Lot 1, 40.34-ac Lse, Blk "D". Kohfeldts Re-Subdn of James Smith Sur.	5- 9-48	9037	8956- 8966	.....	F 321; 1/2"	39.5
Hardin	Batson, W.	Hawkins & Graham Inc's G. Hooks 2, 134-ac Lse, Lot 5, F. H. Green Sur.	5-11-48	6598	6245- 6250	.....	F 77; 1/4"	38.5
Liberty	S. Liberty	Lencir M. Josey et al's Jos. Mitchell Est 6, 614 fr sl 1483 fr wl 160-ac Lse, A.M.G. White Sur.	5-28-48	6606	6291- 6321	Cook mtn sd; Eoc	F 290; 1/8"	38.8
Matagorda	Sugar Valley	Skelly Oil Co's W. T. Robertson 3 (OWWO), 320-ac Lse, Freeman Pettus Sur.	5- 4-48	10200	9311- 9315	.....	F 206; 1/4"	34
Montgomery	Conroe, W.	Sam Pattillo's R. L. Calfee 1, 100-ac Lse, Plk 9, James McDillon Sur	5-12-48	4713	4596- 4602	.....	F 158; 1/2"	30.7
Newton	Gist	Geo. R. Brown & Standard of Texas' Earl Hankamer 1 (OWWO), 660 fr w&sl of 623-ac Lse, R. L. White Sur 22.	5-31-48	7354	5872- 5874	Frio sd; Olig	F 83; 1/4"	28
		TEXAS—District 3 (UPPER GULF COAST)—New Distillate Field						
Chambers	.....	Humble O&R Co's W. C. Tyrell Jr, Tr el sl C-1, 2550 fr nl 467 fr el Sect 65, 345.97-ac Lse, H&TC Sur, 1 mi sw of Anahuac prod.	5-10-48	8815	8728- 8748	.....	F 43; 1.3 mln; 1/16"	43.5a
		TEXAS—Dist ict 3 (UPPER GULF COAST)—Gas Field Extension						
Fort Bend	Needville	Union Prod Co's Annie Sacaris et al 1, 650 fr swl 330 fr sel of 160-ac Lse, Sect 26, H&TC Sur, ½ mi n extension.	5-10-48	6259	4596- 4640	Sd; Miocene	1.7 mln; 1/16"	.....
Wharton	Spanish Camp	Houston Oil Co's Sadie N. Menefee 1, 541.4-ac Lse, S. F. Austin Sur. 1 mi n extension.	5- 9-48	3242	2980- 2998 3150- 3164	Sd; Miocene Sd; Oligocene	1.5 mln; 1/4" 1.8 mln; 1/4"	....
		TEXAS—District 4 (LOWER GULF-S.W.)—New Oil Fields						
Duval	Lovia	R. F. Schoch et al & H. J. Gravis' J. F. Welder Heirs 1, 1010 fr nl 1650 fr wl of J. Poitevent Sur 213, on 320-ac Lse, 1 mi s Seven Sisters fld.	5- 1-48	2684	2662- 2684	.....	P 44	.....
Duval	"Pantex"	Pantex Corp's Dinecio Perez 1, 2000 fr el 1750 fr sl T&NO RR Sur on 588.6-ac Lse, 2 mi ne Richardson fld.	5- 2-48	3207	2593- 2604	.....	P 73	23.7
Kelberg	"Borregas, W."	Humble O&R Co's King Ranch-West Borregas MC-1, 3200 n & 1000 e of intersect of State hiway No. 141 & wl Kleberg Co on 13,399-ac Lse, Santa Gertrudis Gr., 4½ mi nw Borregas fld.	5-17-48	7047	5960- 5964	.....	F 11; 5 wtr; 1/2"	40.2
		TEXAS—District 4 (LOWER GULF-S.W.)—New Distillate Fields						
Kenedy	Sarita	Humble O&R Co's John G. Kenedy Jr E-3, 1680 n 1980 e fr sec Blk 12, Kenedy Pasture Co. first Addn to Sarita Twp, in El Paistle Gr.	5-25-48	10342	5894- 5909	.....	F no gge; 13.5 mln	Cond
Nueces	.....	The Texas Co's State Tr 9-1, 660 fr n&el of 640-ac Tr. in Corpus Christi Bay, 3¼ mi sw Ingleside.	5-10-48	11563	10675-10688	.....	F 122; 3.2 mln; 1/4"	54.6
		TEXAS—District 4 (LOWER GULF-S.W.)—New Distillate Pay						
Brooks	LaGloria	Magnolia Pet Co's Luella Proctor 1, 660 fr s&wl of Lot 6, Blk 19, Falfurria Fm & Gdn Trs Subd, 1¼ mi se extension.	5-25-48	12000	9780- 9800	.....	F 138; 7.8 mln; open	Cond.
		TEXAS—District 4 (LOWER GULF-S.W.)—New Gas Field						
Duval	.....	Cam Corp's G. N. Olson 3, 467 fr sel 3900 fr nel of 491-ac Lse, Sh 4 of El Mesquite Gr., 5 mi s-se of Cam fld.	5-20-48	3038	3004- 3012	.....	3.3 mln; open	.....
		TEXAS—District 6 (NORTHEAST)—New Oil Field						
Wood	.....	Billy Bridwell & F. R. Jackson's G. K. McKenzie 1, 467 fr nl 330 fr el of 30-ac Tr, Jason Sherman Sur, 1 mi ne Alba.	5-10-48	4123	4027- 4123	Sub-Clarksville sd; U. Cre.	P 50	15.6
		TEXAS—District 6 (NORTHEAST)—New Distillate Field						
Panola	.....	G. J. Hollandsworth's Alice Crain 1, 800 fr sel 845 fr nel of 75-ac Tr & J. B. Sweeten Sur, 5 mi ne Beckville.	5-26-48	7012	6538- 6550	L. Pettit sd; L. Cre.	F 1150; 36 mln; open	63.6
		TEXAS—District 7-B (NORTH CENTRAL)—New Oil Fields						
Brown	.....	Dallas Garrett's E. P. Kilgore 1, 330 fr e&sl of w 120-ac of s 260-ac of N. B. Mitchell Sur 153, 4 mi e Crosscut.	5-24-48	2296	2048- 2056	.....	F 127; 1/4"	.....
Callahan	.....	Star Oil Co's Taylor-Ramsey 2, 330 fr n&el Sect 319, Blk 5, SPRR Sur, 5 mi s Putnam.	5-13-48	3953	3944- 3953	Elleburger dolo; Ord	F 160; 1/2"	42.5
Jones	.....	Hester & Hester's Geo. Walker 1, 990 fr sl 330 fr wl Sect 46, Blk 16, T&P Sur, 5 mi ne Abilene.	5- 4-48	2000	1759- 1761	.....	P 14	37
Shackelford	.....	E. H. R. Saben's W. H. Green 20, 330 fr el 1150 fr sl Sect 71 Blk 12, T&P Sur, 15 mi sw Albany.	.....	980	974- 980	.....	P 27	38
		TEXAS—District 7-C (WEST CENTRAL)—Oil Field Extension						
Crockett	Cox	Gulf Oil Corp's H. B. Cox "J" 1, 3750 fr swl 333 fr sel E. Ruiz Sur. 4, nw extension.	4-30-48	1065	883- 910	Queen sd; Perm	P 30	23.7
		TEXAS—District 8 (WEST)—New Oil Fields						
Coke	.....	Seaboard Oil & Southern Minerals' M. G. Reed 1, 1980 fr s&wl Sect 1, HE&WT Sur, 6 mi nw Tennyson.	5-23-48	6219	6182- 6219	Ellenburger dolo; Ord.	F 176; 254 wtr; 3/8"	47
Crane	.....	Gulf Oil Corp's W. N. Waddell 111-E, 660 fr s&el Sect 22, Blk B-25, PSL Sur, 1½ mi n Univ-Ellen pl.	5-26-48	10911	10693-10743	Ellenburger dolo; Ord	F 867; 1/2"	46.2
Gaines	.....	Anderson-Prichard Oil Corp et al's E. H. Jones 1, 220 fr s&wl, Sect 21, Blk A-7, PSL Sur, 5 mi se Jones Ranch pl.	5-20-48	7850	6030- 6130	Glorietta sd; Perm	P 223; 31 wtr; open	35
Mitchell	.....	R. J. Wallace's W. L. Foster 1-B, 1650 fr sl 330 fr el Sect 5, Blk 29, T-1-S, T&P Sur, 1 mi ne Iatan-E. Howard Fl.	5-21-48	2955	2715-	.....	P 21	31
Reeves	.....	C&B Oil Co's M. G. Hansbro's Monroe 1, 330 fr s&wl Sect 13, Blk 2, H&GN Sur, 2 mi s Dixieland.	5-15-48	3911	3858- 3885	.....	P 82; 10 wtr	40
Reeves	"Cosby-Betchel"	C&B Oil Co's Ollie P. Anderson 1, 330 fr nwl, 1650 fr swl Sect 18, Blk 2, H&GN Sur.	4-20-48	3939	3835- 3939	.....	F 73; 1/2"	35
		TEXAS—District 8 (WEST)—New Oil Pay						
Crane	Gib	Lion Oil Co's Cowden "B"-1, 330 fr sl 990 fr wl Sect 13, Blk X, CCSD&RGNG Sur.	5-19-48	2881	2755- 2800	.....	F 329; open	27.8
		TEXAS—District 8 (WEST)—Oil Field Extension						
Ector	Jordan-Ellenburger	Amerada Pet Corp's Hattie E. Connell 1, 1984 fr nl 1926 fr wl Sect 12, Blk B-16, PSL Sur, 1½ mi n extension.	5-22-48	8935	8906- 8925	Ellenburger dolo; Ord	F 328; 1/4"	44.8
		TEXAS—District 9 (NORTH)—New Oil Fields						
Cooke	.....	P. G. Lake Inc's Pace Bros "A"-3, 885 fr sl 990 fr wl N. R. Reed Sur, 2 mi sw Gainesville.	5-10-48	2638	2603- 2626	.....	P 35	19.5
Cooke	.....	R. W. Fair & Paul B. Scott's Paul Rivoire 1, 330 fr n&el T. G. Murphy Sur, 1½ mi w Gainesville.	5-15-48	1969	1929- 1932	.....	P 10; 10 wtr	40
Jack	.....	Cox Drlg Co's J. T. Roney 1, 330 fr sl 484 fr wl Sect 3326, TE&L Sur, 3½ mi se Ellis fld.	5-23-48	5724	4580- 4602	Caddo li; Penn	F 600; 1/64"	42
Young	.....	Warren Oil Corp's Allar "K"-1, 1400 fr s&wl of Sect 1653, TE&L Sur.	5- 3-48	3639	3634- 3639	Caddo li; Penn	F 175; 1/8"	41
		TEXAS—District 9 (NORTH)—New Oil Pay						
Young	Walsh	Cities Service Oil Co's T. L. Mayes 2, 660 fr e&sl Sect 2373, TE&L Sur.	5-17-48	4315	4286- 4315	Marble Falls li; Penn	F 422; 1/2"	42.7
		UTAH—New Gas Field						
Carbon	.....	Pacific Western Oil Co's Unit 1, c se ne, 24-14s-7e, Gordon Creek Feature.	5-25-48	12146	10890-10980	Sinbad sd; Tri	8.5 mln; 3/8"	.....
		WYOMING—New Oil Fields						
Albany	.....	Superior & California Oil Co's Parkinson-Sherwood 1, 2310 fr nl 330 fr el se se ne 5-16n-75w, Little Laramie Dome.	5-28-48	3824	3741- 3764	Casper (Tensleep) sd; Penn	Sw 210	22
Natrona	West Poison Spider	Pure Oil Co's Unit 1, c nw se 11-33n-84w, East flank of Wind River Basin.	5-31-48	14307	14191-14307	Frontier sd; U. Cre	F 900; 3/4"	43.5
Park	.....	Taylor Oil Co's Thelft 1, c sw sw 23-48n-103w, Franks Fork area	5-28-48	4370	4134- 4145	Embar li; Perm	P 50; 75 wtr	.....
		WYOMING—New Gas Field						
Carbon	.....	Rocky Mtn Gas Co's Unit 1 (OWDD), 630 fr nl 900 fr el nw ne ne 17-26n-86w, Pic Sandy Unit.	5-28-48	2561	830- 885	Frontier sd; U. Cre	0.1 mln	.....

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plic, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

New Design of Portable Rig
SPEEDS RIGUP AND MOVING JOBS

GILBERT M. WILSON
Staff Writer

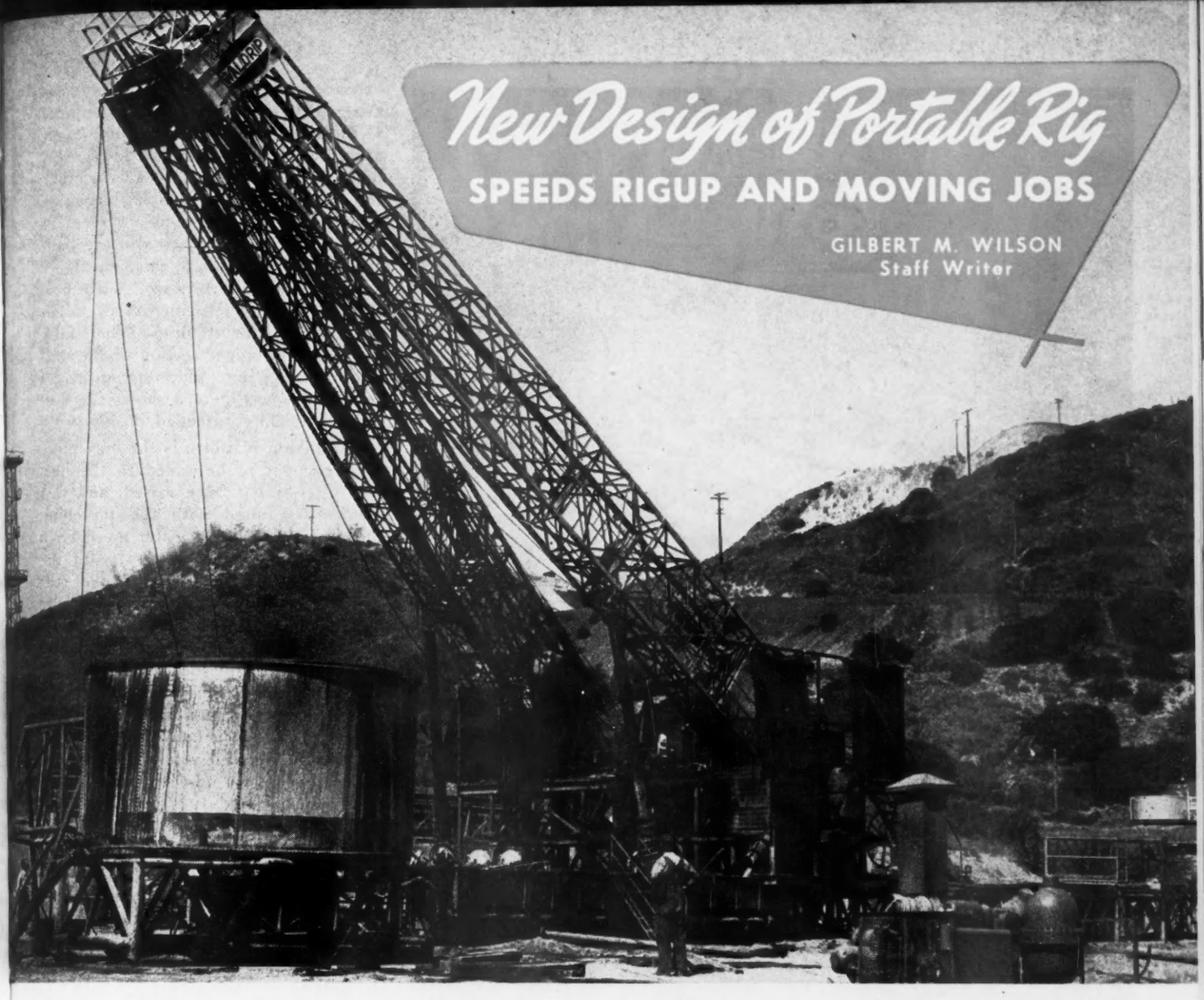


FIGURE 1. In a few hours, this completely portable, 900-horsepower all electric rig, shown with telescoped derrick being erected by its two hydraulic rams, will be spudding in another 10,000-foot well. Designed to cut setting-up costs in rugged hills of Ventura, California field, this rig already has demonstrated that savings of $5000 per well are possible. Upon reaching vertical, the derrick then is extended to its full 123 feet height.

TWO years ago engineers of Shell Oil Company, Inc., set out to design from the ground up an entirely new type of drilling rig . . . one that would be capable of drilling to 10,000 feet, could be broken down into completely portable, legal load "packages" for highway travel, and which would have flexibility, safety and efficiency.

Such a rig was designed, built, tested, and only recently placed in regular service. To the credit of Shell engineers and equipment manufacturers concerned, the rig on its first several locations has amply demonstrated that it will perform exactly as designed, and at savings in costs that more than justify the expenditure of $250,000, the approximate over-all cost.

Principal objective of the company in designing the unit was to overcome, at least partially, the extraordinarily high setting-up and moving costs encountered in the hilly terrain of the Ventura field located about 100 miles up the coast from Los Angeles. Whereas the normal average cost of rigging-up on a typical location used to be on the order of $10,000 to $15,000, present rigging-up costs with the new equipment is in the order of $5000. In addition, the reduced cost does not take into consideration the very real saving being realized in the increased footage which the rig will be able to drill due to the reduced time spent in setting-up and tearing down at each location.

Outstanding features of the new rig (Figure 1) are (1) the unusual new type collapsible two-legged mast; (2) the flexible all-electric direct current d.c. drive; (3) the under-floor drawworks; (4) the "console" type control panel at the driller's position; (5) provision for racking drill pipe directly on the ground; (6) independent support of the rotary table on the drilling riser; and (7) complete portability in the form of specially built trailers with pneumatic tires. The rig was designed to drill a 9⅞-inch hole to

ATTAINING GREATER PORTABILITY and lessened highway loading were twin objectives attained when the rig described herein was designed. Notable because of its many departures from conventional practices, the rig may open the way for new approaches to the problems inherent in deeper drilling.

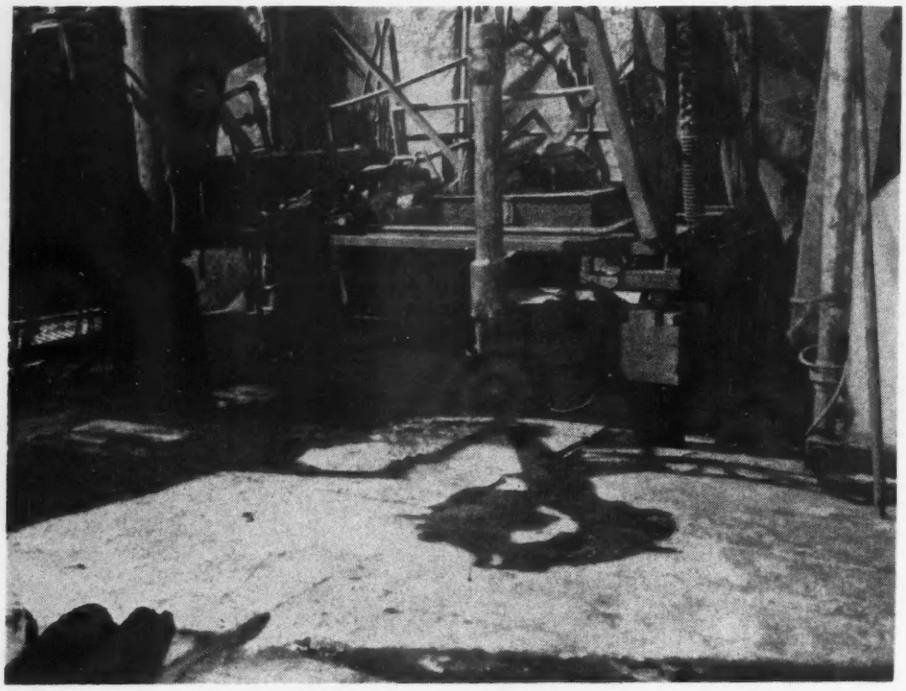


FIGURE 2. Closeup of one of the two mast bases as seen from near the rotary table. When derrick is to be lowered, rams (not visible but at right) must first lift derrick in order to allow removing of rear locking pins. Note that inboard leg rests on ball-socket joint which permits necessary movement when raising of top mast section changes angle of lower base section.

10,000 feet. It is believed to be the first completely portable 900-horsepower rig designed for drilling to such depths.

During the early planning stages it was found that a number of entirely new concepts would have to be developed and incorporated in the rig if it were to be completely portable and yet contain the desirable and essential features necessary to reduce costs for operation in the hilly region. In the first place, a mast that could be moved in one piece was necessary. If over-all weight of the rig was to be reduced, lighter bases would have to be designed. All possible equipment would have to be wheel mounted, and if possible, be set up at or near truck height to facilitate moving when rigging up and tearing down. Ample clearance would have to be provided for blowout preventers and rams without having to dig deep cellars. In addition, the need for highly accurate alignment of bases, drawworks and other attendant equipment would have to be reduced to a minimum. Throughout all the planning of these departures from conventional equipment, the fact was not lost sight of that safety to the men and efficiency of drilling also were of paramount interest.

In the preliminary studies of the new rig, a complete set of scale models of the new mast, light-weight bases, drawworks, and drawworks turntable was built and experimented with before actual construction of the full size equipment was started. These experiments proved that the original and basic ideas were sound.

Most impressive feature of the rig at first sight is the new-type mast. It is a fabricated "A" frame which stands vertically, independent of guys for structural support. Capable of handling 10,000 feet of 4½-inch drill pipe in 90-foot stands, this unique derrick measures 123 feet between the derrick floor and the base of the water table. The structure has no cross braces between the two fabricated legs, thus giving the driller a clear view of the blocks and derrickman at all times. When the upper half of each leg is telescoped into the lower section, and the whole laid down horizontally, the legs are brought together to form a compact, single 8x8x63-foot piece for moving on the highway. With blocks strung, the unit weighs approximately 36,000 pounds.

Elevating and lowering the telescoped derrick is done by two large hydraulic rams, one under each of the legs. A number of safety devices have been incorporated into the mechanism for erecting the derrick. The rams are equipped with outlet orifices that control the speed at which the derrick can descend even should the oil lines be broken or disconnected. In addition, provision was made for making it impossible to lower the derrick until it is first raised off the rear locking pins (Figure 2). This prevents lowering the derrick when the rams are not in working order.

The derrick is extended and telescoped by means of two electric motors driving four sprockets through worm reduction gears. The motors are permanently mounted in the base of the upper section of the derrick. The rotation of the sprockets causes the upper sections of the two legs to "climb" four chains attached within the lower section. The worm gear serves as a brake and holds the upper section in position should the power for any reason be turned off. Safety latches also are built into the lower section to catch the upper section should any series of mechanical failures occur which conceivably might cause the section to drop. When fully extended, the upper section of the derrick is locked into place by means of safety latches. Figure 3 shows the derrick in its fully extended position.

The tubing platform is the only piece of equipment to be added to the derrick after it has been raised, and this element is raised with the travelling block as a single unit. After the derrick is up and guys are strung, one of the hydraulic rams, that passing over the driller's controls, is removed in order to give more unobstructed room for the driller. The other ram is protected from mud and water splashes by sheathing it in a collapsible canvas tube.

This derrick is the first installation of its type that has a hook load capacity of 300,000 pounds, yet which can be moved over the highways as a single legal load package. It is significant that a derrick of similar design, but having a hook-load capacity of 460,000 pounds, now is on the drawing board.

Possibly the next most outstanding feature of the new rig is the location of the drawworks. This unit is under the derrick floor, with only the extended catshaft being visible above the floor.

Truck Height, Under-Floor Drawworks

In designing the truck bed height, under-floor drawworks, Shell engineers recognized that they would have to sacrifice head room under the derrick or design a special drawworks which would suit the conditions desired. The latter course was chosen, and working closely with equipment company engineers, they developed a special drawworks equipped with a catshaft which extended up to normal working height above the derrick floor. In addition, remote controls were developed which enable the driller to sit at a special console and have control over every piece of equipment on the rig.

One of the most difficult of the control problems was designing the remote-operated speed control of the hoist and rotary table motors. Ordinarily, these controls would require rotation of the rheostat wheel a full 330 degrees to obtain a wide range of speeds in both forward and reverse. However, hydraulic truck steering controls, together with

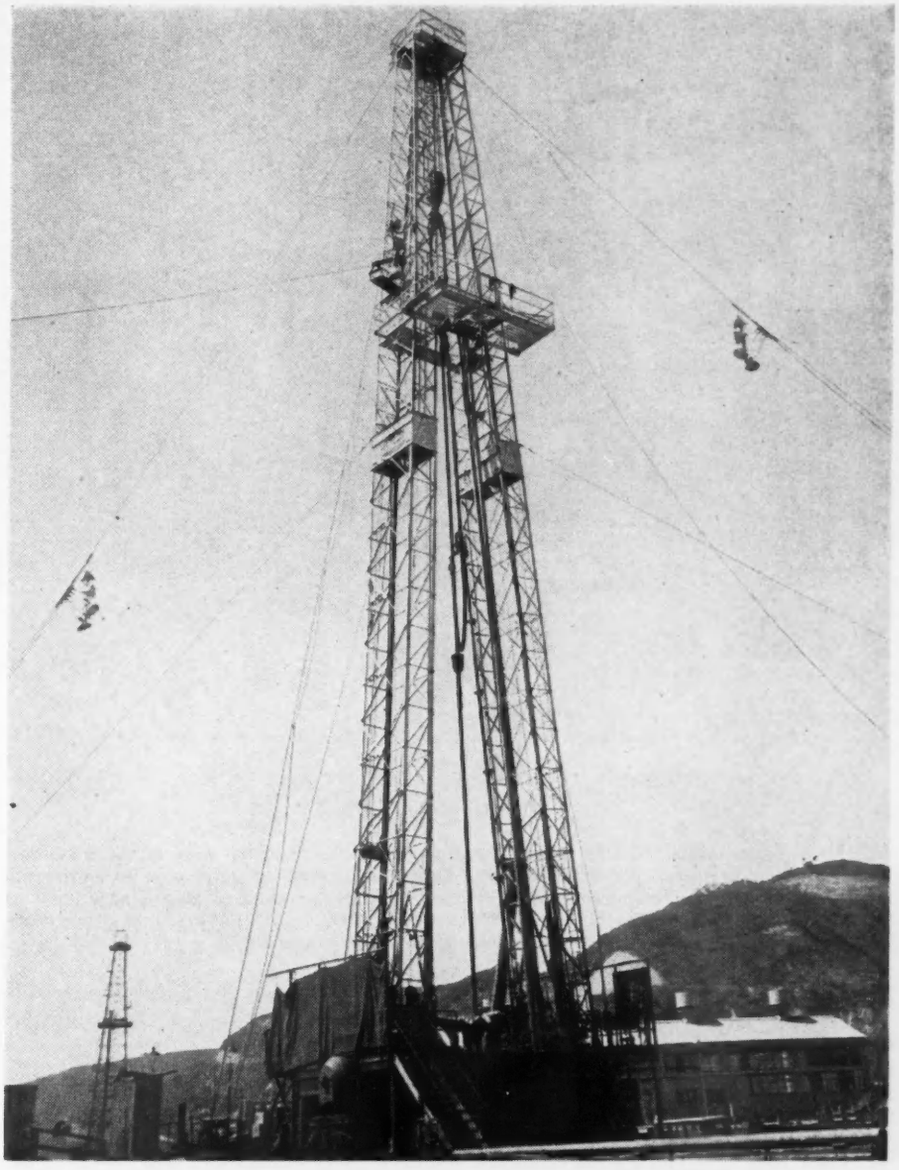


FIGURE 3. View of fully extended derrick taken from pipe-rack side of rig. Barely visible inside the mast structure are chains on which upper telescoping section "climbs" as mast is extended. Rig is capable of drilling 9⅞-inch hole to 10,000 feet.

—Shell Photo

conventional master and slave controls, were successfully employed, solving the electric motor speed control problem. Air clutches, commonly used in other installations, solved the problem of clutch control. For remote control of the drawworks, hydraulic brakes, a high pressure booster pump with valves to control pressure applied to brakes, solved that problem. The degree to which driller's controls were simplified may be seen in Figure 4, which shows the driller at his console. From this vantage point, the driller has instant, finger-tip control over every operation. The ingenious, all-steel adjustable, cushioned swivel chair in which the driller sits while at the controls contributes to the general comfort and well-being of that individual during the long hours when he must remain at his post looking upward or otherwise concentrating on a particular operation.

The most noticeable variation from conventional makeup in the drawworks is the raised catshaft which permits conventional use of catheads. An air controlled spinning cathead is installed on the rotary end of the shaft, and an air controlled master break-out cathead is installed on the driller's side. Figure 5 shows an under-floor view of the drawworks assembly as it appeared in the shop just prior to its being taken into the field.

Another departure in the drawworks assembly is the fact that the sand line reel and drive was made an integral part of the selective speed transmission assembly, the latter being carried on a separate trailer along with the drawworks motor and certain pieces of smaller equipment. In order to keep this trailer within the eight-foot legal road width, and still have it tied in with the design of the drawworks, it was necessary to do considerable redesigning of the sand reel drive. The conventional sand reel with air clutch was used, but it was rotated through 180 degrees and the drive changed to the sand reel. The sand reel installation represented a comparatively minor change in the equipment but it serves to illustrate the extent to which engineering was applied to achieve the desired results.

FIGURE 4. Seated at his specially designed "console" the driller has fingertip control over every phase of the rig's power equipment. He has full view of derrick floor and unimpeded view of upper portions of derrick. Note "automatic driller" control at driller's right.

Turntable Mounting

An ingenious feature built into the drawworks base is the turntable device which permits the entire drawworks, on its base, to be turned through 90 degrees, that is, from the conventional rig position to the in-line position for hauling along the highway, the entire operation being done without the aid of cranes.

To understand better the operation of this device, the principal steps followed

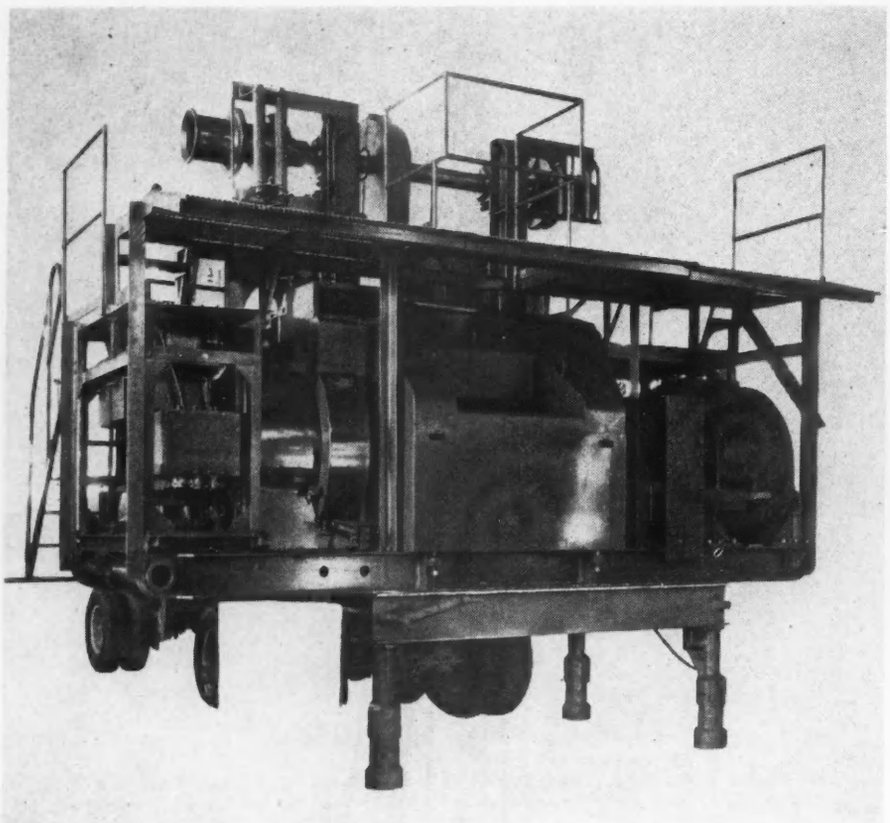


FIGURE 5. Taken inside the shop before it was moved to the field, this view of the drawworks assembly set up in drilling position was viewed from a point that normally would be underneath the derrick floor. Floor level is indicated by open mesh steel decking visible in upper part of assembly. Photo shows relationship of drawworks, eddy current brake (right), elevated cat shaft, and the turntable base with its four hinged legs.

in a typical rigging-up operation will be described. Mounted on the trailer in position for hauling along the highway, the drawworks appears as in Figure 6. This view, taken from the back side of the drawworks, shows the unit with sand line reel and drive components detached, but complete with ladders, platforms and electric cables. In approaching the rig, the truck and trailer are backed into the open area between the two longitudinal truss sub-bases, the drawworks and its base being parallel to these sub-bases. Shortly before it reaches the final position, the drawworks is swung through 90 degrees on its turntable, and the truck then backed a little farther until the unit is in the final position with respect to the rig floor and other assemblies that will be brought in later. At this point, four hydraulic jacks, two on each side of the drawworks, and which are built into the derrick sub-base (see Figure 7), lift the drawworks and turntable clear of the trailer bed, enabling the truck to pull away. The short turntable base then is swung around until it again is parallel to the drawworks base. Four adjustable supporting legs, hinged to and built as an integral part of the turntable base, then are swung down from their racked position up in the base and set up on the concrete mat. The hydraulic jacks are lowered until weight of the drawworks is taken up by the derrick sub-bases and the four turntable legs.

The reverse of this process is followed when the rig is being torn down. The hydraulic jacks are used to lift the unit, the base legs are swung back up into the turntable base, and the truck trailer is backed in underneath the unit, after which the hydraulic jacks again are lowered, placing the weight on the trailer bed. The truck pulls away a few feet, the drawworks assembly is swung through 90 degrees to the in-line position, and it is ready to be hauled away. An important feature in this entire process is the fact that precise spotting of the unit is possible without the aid of cranes or other heavy moving equipment. Setting the drawworks in place can be done in from 30 minutes to one hour.

Self-Aligning, Light-Weight Bases

One of the significant achievements of the Shell engineers was the substitution of light-weight bases for the heavy bases heretofore considered essential on a rig of this depth capacity. This design was made possible by two other major departures in conventional rig design: (1) a method of removing the weight of the drill pipe from the derrick floor by racking it directly on the ground; and (2) construction of a special device which allows the rotary table and its heavy load to rest directly on the drilling riser instead of on the derrick bases.

The entirely new type of light-weight base was designed and built in four pieces. It is constructed to permit its being moved in a legal load on a single semi-trailer. The two longest pieces, placed on the ground with their length parallel to the rig assembly and racks, consist of two truss sections, each measuring 4 x 4 x 45 feet. Mounted atop these racks are two cross-truss sections each measuring 5½ feet wide and 7½ feet high on the ends. The cross trusses, handled as a single unit when moving in the field (Figure 8), have five-foot deep truss sections and are 24 feet long. Placed five feet apart, these cross-truss sections provide a floor 16 feet wide by 30 feet long. By reducing the depth of the central section of the cross truss, it was possible to obtain an 11-foot, 6-inch high derrick floor and yet maintain 7-foot head room under the drilling floor.

Positive, safe alignment of the truss sections is assured with the aid of conical, self-aligning pins and sockets. In rigging up, the longitudinal bases are set parallel and in the proper location with respect to the hole center, and the cross trusses then are set in place, guided by the pins and sockets. After the bases are in place, all pipe fittings and electrical connections mounted in and forming integral parts of the sections are coupled with quick-acting unions and couplings. Little or no pipe fitting is required at the new location.

Various auxiliary pieces of equipment are mounted within the bases sections. Viewed from the mud tanks, looking toward the derrick, the left-hand longitudinal base carries the fluid pump, motor, and fluid reservoir tank which operate (1) the hydraulic drill pipe racking equipment (described elsewhere); (2) the hydraulic jacks used in positioning the drawworks; (3) the hydraulic rams used to raise and lower the derrick; and (4) in an emergency, supplying power to the drawworks hydraulic brakes and other hydraulic controls. Standpipe manifolding also is mounted within this section. In the right-hand section is mounted an air receiver, and in addition, the base supports the removable mud ditch.

The unique design of the sub-base system has eliminated many of the problems normally found in conventional bases. The 11-foot, 6-inch high derrick floor, with no posts under it for support of the rotary table, allows room for the mounting of heaviest capacity blowout preventer equipment without hindrance of adjacent base members. The seven-foot clearance under the drilling floor allows the crew to work more rapidly and without discomfort when

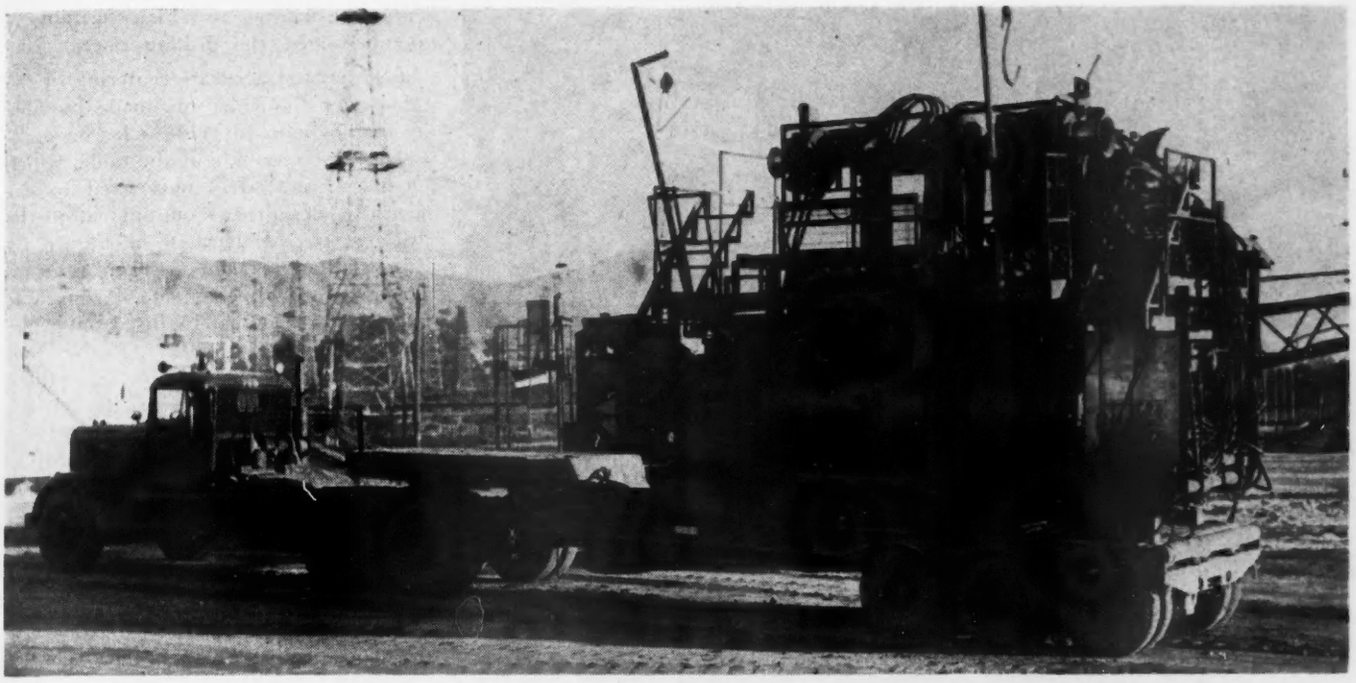


FIGURE 6. For moving along the highway, the drawworks, complete with walkways, stairs and raised catheads, all mounted on the permanently installed turntable base, is carried on a 3-axle semi-trailer. It complies with statutory weight and road width requirements.

rigging up, connecting fittings, setting blowout preventers, etc.

As mentioned earlier, a new system was developed for the racking of pipe directly on the ground. By so doing, the tremendous weight of a 10,000-foot string of drill pipe never rests on the derrick bases, bringing about the light-weight bases described above. Two rectangular "wells" cut in the derrick floor are located on either side of the rig floor area opposite the driller's position. From 50 to 60 ninety-foot stands of 4½-inch drill pipe may be racked in each well, the latter being covered with hinged trap doors of open mesh steel flooring when not in use. Besides taking the weight off the derrick floor, this method of racking allows drill pipe to drain into the cellar, thus keeping the floor cleaner and safer. Figure 9 shows the general arrangement of equipment on the floor and surrounding area as viewed from the derrickman's position.

A unique feature developed to simplify racking with this new system is the specially designed, power-operated chute with which a stand of drill pipe can be directed to any point on the racking area beneath the derrick floor. The chute consists of a rubber-lined steel slide pivoted as near as possible to the rotary table. The lower end of the chute is movable in any direction by means of three jack screws driven by remote controlled hydraulic motors. Visible in Figure 10, these motors travel along continuous screw-threaded shafts and rapidly position the lower end of the chute before the stand is lowered on to it. An important consideration is that with this device, the derrick floor man always releases the stand at the same

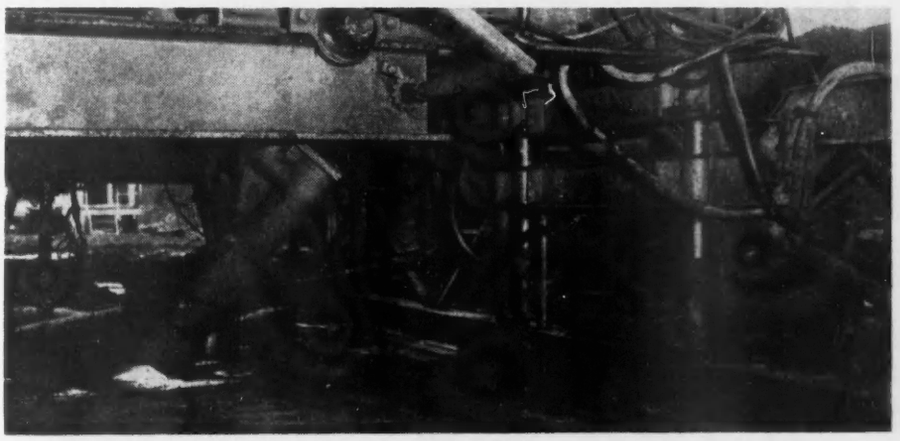


FIGURE 7. This view, taken just after the truck trailer has been pulled away, shows drawworks supported and raised by hydraulic jacks permanently built into the movable sections in the longitudinal sub-base. While the unit is thus supported, four legs are lowered from within the turntable base and set up on concrete mat. Hydraulic jacks then are lowered, allowing weight to fall on sub-base members and the four legs. Crank in foreground is used to wind up cable which lifts heavy legs into retracted position.

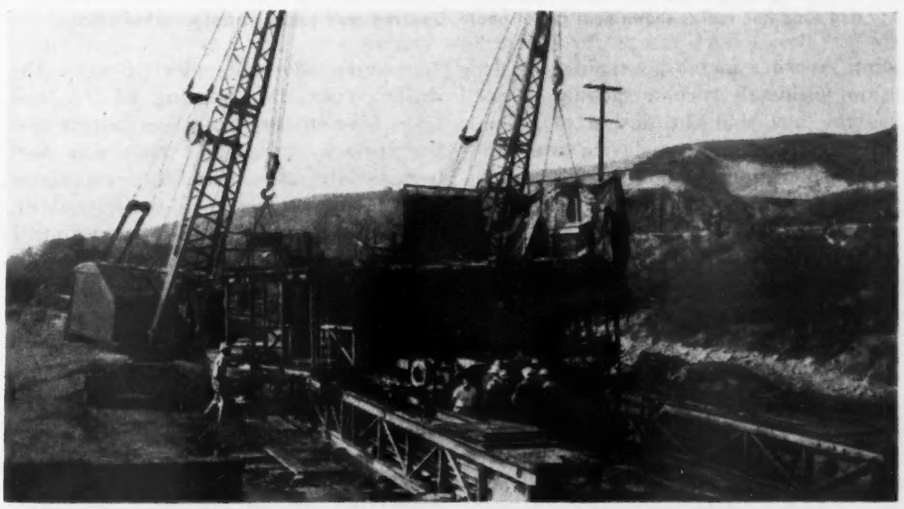


FIGURE 8. In assembling the light weight base, cross truss sections are placed atop the longer sub-bases as shown. Positive, safe alignment of truss sections is assured with aid of conical, self-aligning pins and sockets. Note how mud lines, hydraulic equipment, etc., are built into sub-base.

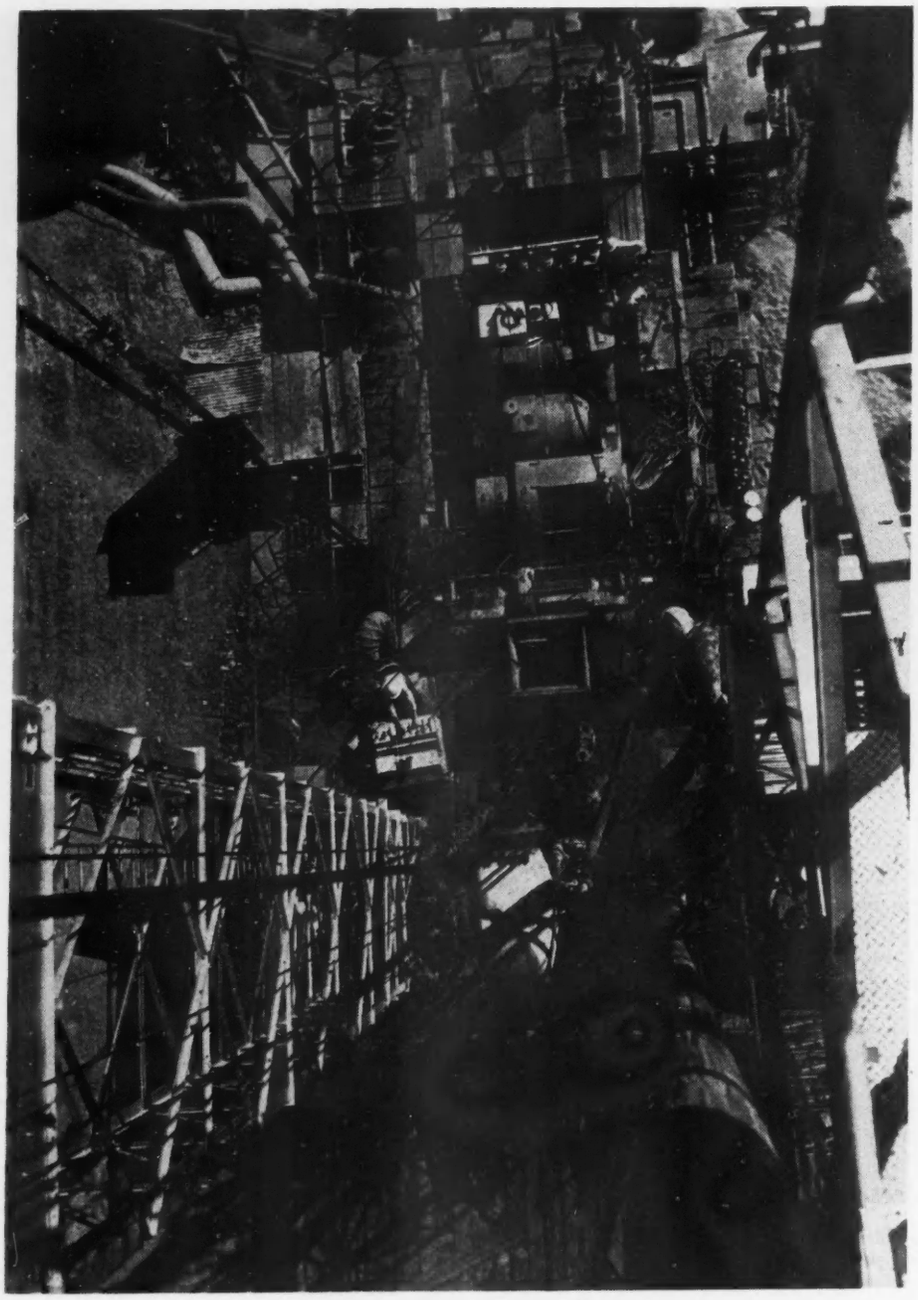


FIGURE 9. This derrick man's view of the floor shows general appearance and relationship of equipment. Driller's console is at left corner of floor. Note that only extended cat shaft and drilling line in floor opening mark location of drawworks. Trailer carrying drawworks motor, transmission and sand line reel is shown near top of photo. Unitized mud tanks partially visible beyond.

point. Another factor governing the decision to install such a racking device was the fact that the design of a mechanical pipe-breaking device was under consideration, the operation of which would be greatly simplified with the mechanically controlled chute since the latter would always discharge the pipe at a predetermined point beside the pipe well.

Table on Drilling Riser

Great loads are imposed upon the rotary table and its supporting structure when a long string of drill pipe or casing is suspended in the hole. Rather than mount the table on the substructure, which would necessitate heavy supporting members, engineers devoted considerable study to the possibility of supporting the table directly upon the drilling riser, thus placing all the load upon blowout preventer equipment and the surface string. The plan was perfected only after careful consultation with manufacturers of rotary tables, blowout preventers and pressure control equipment. Originally, it was feared that vibration imposed upon the surface string might affect the cement job or otherwise injure the surface pipe or fittings. However, by stiffly bracing the surface flanges, and taking positive measures to assure the table being spotted over the exact center of the hole each time it is installed, the new supporting system proved successful. Figure 11, taken from a point directly beneath the rotary table motor, illustrates the manner in which the table is mounted atop the drilling riser.

Positive and accurate centering of the table over the hole was made possible by four cylindrical guide holes or sockets in the under side of the table, which fit over heavy steel pins fixed to the specially designed mounting atop the drilling riser. Illustrated in Figure 12, this installation facilitates rapid removal and accurate replacement of the table when that unit must be lifted out while casing is being run or during other routine operations. The table, separated from, and mounted with its surface slightly above the derrick floor level, does not transmit damaging vibrations to the derrick. Only during initial stages of the drilling—that is, before blow-out preventer equipment is installed—does the table rest directly upon the truss base.

The rotary table is driven by a 250-horsepower direct current electric motor located below the derrick floor near the end of the two cross trusses. Shown in Figure 3, the motor rests on an elevated structural steel platform between the two transverse bases. The drive from motor to rotary table is by means of a drive shaft equipped with universal joints. The use of a separate rotary table motor makes possible a derrick floor clear of guards and allows the drawworks motor to remain idle during routine drilling. Figure 13 illustrates the surface of the rotary table as it appears from the floor during drilling operations. Lock pawls are remotely controlled by air from the driller's position.

Wheel-Mounted Units

With the exception of several major pieces, such as the mast, sub-base, conventional tanks and pipe racks, which are handled with cranes, drilling equipment is either wheel mounted or provided with special loading features. Two slush pumps with their electric motor drives, a double mud tank, a chemical tank, three internal combustion engines and connected generators, the change house and the drawworks speed selection transmission and drawworks motor unit all are separately mounted on wheels with pneumatic tires.

Two slush pumps are provided with the rig. A 7¼ x12 triplex pump powered by a 400-horsepower electric motor is mounted on one trailer, and a 7¾ x 16 pump powered by a 250-horsepower motor is mounted on the other. Each trailer, including pump, motor, V-belt drives and guards, is of legal road width and is mounted on eight 10.00 x 15 tires. The triplex pump trailer is constructed with the pump frame an integral part of the trailer frame. The trailers are slung very low, having about 12-inch clearance. The pumps and their

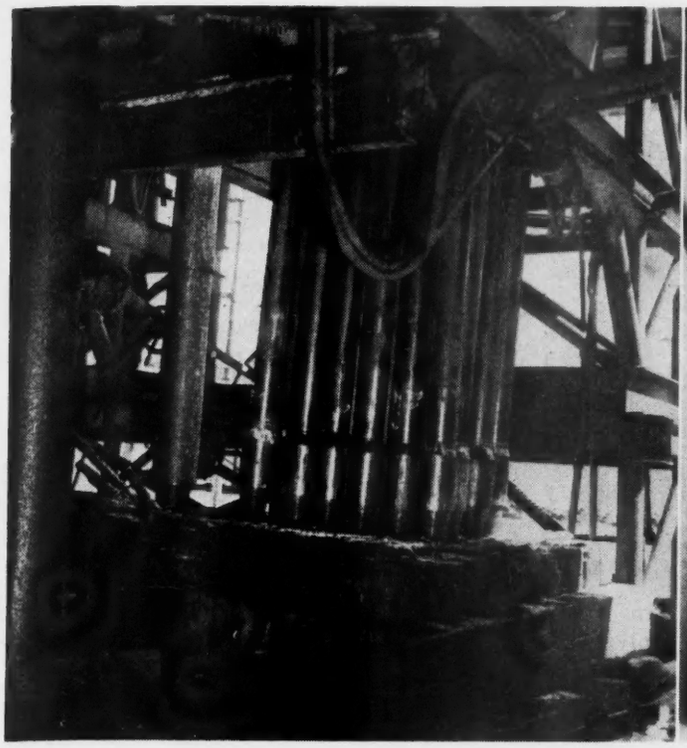


FIGURE 10. By racking drill pipe directly on the ground, heavy sub-bases were made unnecessary. This view shows drill pipe as it appears from beneath floor. Visible near underside of truss section are the remote controlled hydraulic motors which, traveling along continuous-thread shafts, move the lower end of a steel chute or guide with which pipe is guided and racked in the proper position.

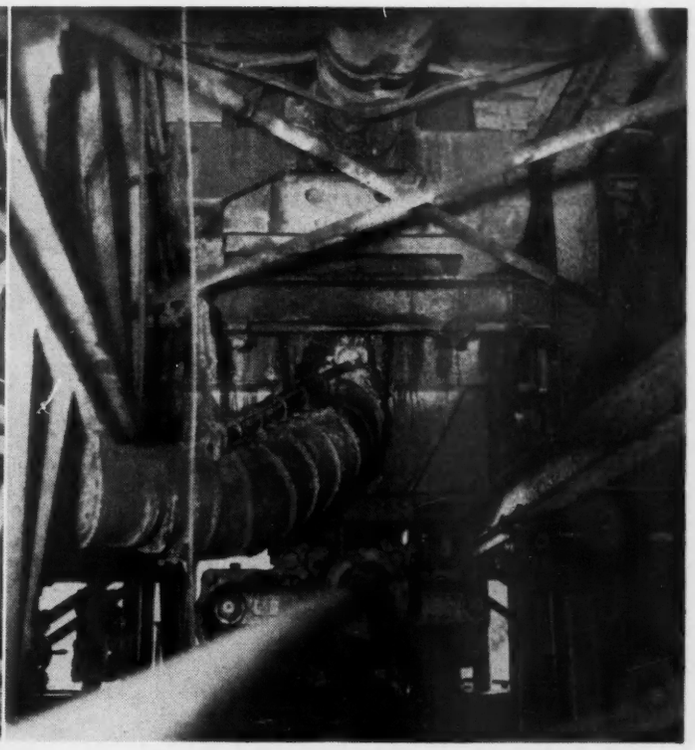


FIGURE 11. This photo, taken from point just below rotary table motor, shows how table rests on specially designed structure mounted atop drilling riser. The short I-beam cross members visible, support table only until blow out preventer equipment is installed. Rotary table drive shaft is visible at extreme top of photograph. Note flexible mud ditch spanning interval between well head and permanent mud line.

individual motor drives are easily moved by any truck and are the first major pieces to be moved away from the location, and the last to be located when rigging up at the new location. Figure 14 shows the triplex pump being backed into its position between the smaller pump and the portable mud mixing chemical tank. Because of their high degree of mobility, the pumps can easily be parked off to one side of the location while waiting for other equipment to be installed.

Connections from the pump to the mud suction tank and from the pump discharge to the mud manifolding system are through quick-acting couplings. The suction line contains an offset connection, sliding tank sections and coupling. Ball joints permit discharge line misalignment by as much as six to eight inches in three directions between the pump trailer and the mud tank. Each pump has flooded suction and has a suction line less than two feet long. Foot-operated valves are used on the flooded suction of each pump.

The mud tank unit includes dual manifolding of discharge and flexible connections through ball joints to all derrick base lines. Quick-opening and large volume gates allow the crew to clean or empty the tank in a minimum of time. The mud tank is divided so each pump has its own section and an inside mud ditch diverts the returning mud into either compartment. This arrangement allows the mixing of chemicals in one section while the other is supplying mud to the main circulating pump. Misalignment between the mud ditch and the tank is taken up in a section of canvas ditch about three feet long. This canvas link is supported on spiral steel hoops which slide on steel guide rods.

The drawworks motor and selective speed transmission are mounted on a three-axle trailer that includes the electric cable terminal board as well as other electrical equipment. The trailer is four feet high at the top of the base supporting the transmission. As shown in Figure 15, extensions of open-mesh steel flooring hinged to the sides of the trailer, span the open area between the trailer and adjacent sub-bases. After the trailer is spotted, these hinged extensions are lowered to form a platform. The sand line reel mounted on this trailer rests upon an elevated platform over the selective speed transmission case. Like other equipment on the rig, the reel, and drives are covered by housings to prevent injury and unnecessary maintenance due to mud and water splashes, and dust. Twelve 9.00 x 20 tires carry the load of this trailer unit.

The double mud tank used as a pump suction tank is unusual in that it is mounted on a single trailer axle to form a semi-trailer. It is so constructed that, when set up for operation, the bottom of the tank is only about four inches off the ground. To lend additional support to the tank when it is full of mud fluid, short steel beam sections were attached at intervals along the sides of the tank. Normally swung up out of the way when the tank is moved, the legs can be lowered and set on the ground when the unit is set up for operation. When the tank is to be moved, it is emptied, and the front end then raised up on to the fifth wheel of a tractor truck. Through the combination of the fifth wheel lift and the rear trailer spring lift, the steel supports clear the ground, permitting the trailer to be hauled away. The single axle is equipped with four 7.50 x 15 tires.

The chemical mud tank also is mounted on a semi-trailer axle and is equipped with a gooseneck for hauling. The tank contains a series of smaller tanks where premixed liquid and chemicals may be stored. The system includes a chemical pump which can be controlled from the driller's position. As shown in Figure 16, the tank is covered over at truck height with a platform on which dry chemicals can be unloaded and temporarily stored. It is anticipated that this single unit will adequately handle most of the drilling mud problems likely to be encountered in the Ventura field. Like the mud tank described above, this easily moved unit also is mounted on a single axle equipped with four 7.50 x 15 tires.

The generators and their prime movers are located out of the way, and they

can be moved at almost any time. They are mounted on two semi-trailers (Figure 17), as it is generally possible to shift them in one continuous move from the old to the new location. They are carried on two-axle semi-trailers supported on eight 8.25 x 15 tires. The trailer units are equipped with removeable steel roof coverings to which are attached roll-up type canvas side curtains.

All-Electric Drives

Although other types of drives could have been employed on this new rig, problems presented by drilling conditions in the Ventura field made it more desirable to use an all-electric drive. Because of the very precipitous terrain, roadwork and grading was an unusually expensive factor that had to be considered. By cutting long and narrower locations on steep hill sides, grading costs could be reduced, hence the desire to construct a rig powered with prime movers adapted to in-line installation. Also important is the fact the prime movers and generator units would not necessarily have to be spotted on the same level as that on which drilling equipment was installed, since they could be connected with cables and quick-engaging polarized plugs and receptacles.

FIGURE 12. Shop view of specially-designed box-like structure mounted atop drilling riser. Rotary table, with four guide holes in its under side, is accurately positioned over exact center of hole by lowering it over four guide pins shown above. Mud return line attaches to opening on side of device.

One of the two semi-trailer mounted generating units is a 12-cylinder natural gas engine, its 200-kilowatt direct current generator and the main control panel. This is the unit shown in Figure 17. On the other trailer are mounted two 12-cylinder gas engines, their two 200-kilowatt generators, two air compressors and their electric motor drives. Each of the three direct current generators is rated at 200 kilowatts, 395 volts and 506 amperes at 1450 revolutions per minute, with separate excitation from a 15-kilowatt generator mounted on the frame of the main generator. To minimize danger of fire or explosion originating from the generating plant, the trailers are spotted a minimum of 100 feet from the rig.

A unique method evolved for handling and transporting the five principal electric cables is contained in the five-section, special reel mounted on the front end of one of the power generating trailer units (Figure 17). Upon completion of a well, cables are disconnected and the end of each is secured to its individual section of the reel. A truck winch line is secured to a narrow flanged sections on one end, wrapped around it a number of turns, and the winch then clutched in. One man is stationed at each cable to guide it as it is coiled up on the slowly rotating reel. Approximately 30 minutes are required to reel in all cables. The unit is a shop-made device about eight feet long and having a cylinder diameter of four feet. The partitions are of three-inch pipe and extend 18 inches above the surface of the drum. Figure 17 shows the winch line reel to which are welded hand spokes to aid in turning the unit by hand in coiling the winch line.

Oil-resistant synthetic rubber sheathing protects the electric cables from moisture and the severe service they normally receive. Explosion proof plugs are employed which are simplified to the extent that they can be plugged in by hand, requiring no wrenches or special tools. To prevent accidental disconnecting of a cable, each plug is equipped with two small wing nuts which secure the connection until it is deliberately disconnected.

Motor Ratings

The larger of the two slush pumps is powered by a 400-horsepower, 395-volt, 820-ampere direct current electric motor operating at 900 rpm. The second pump is powered by a 500-horsepower, 395-volt, 510-ampere motor. The drawworks

FIGURE 13. Derrick is not subjected to damage from vibrations with rotary table mounted directly upon drilling riser. Table nearly flush with floor level facilitates work of crew. Table lock pawls are remotely controlled from driller's console. Note drill pipe standing in open rectangular well in background.

FIGURE 14 (left). View showing one of the two pump trailers being backed into position between second pump and portable mud chemical tank trailer. Pumps are first units out and last to be moved in.

FIGURE 15 (below). Viewed from point near mud tank, this photo shows trailer on which is carried drawworks motor, transmission, modified sand line reel and electric cable terminal board. Note open mesh steel hinged decking which spans side areas.

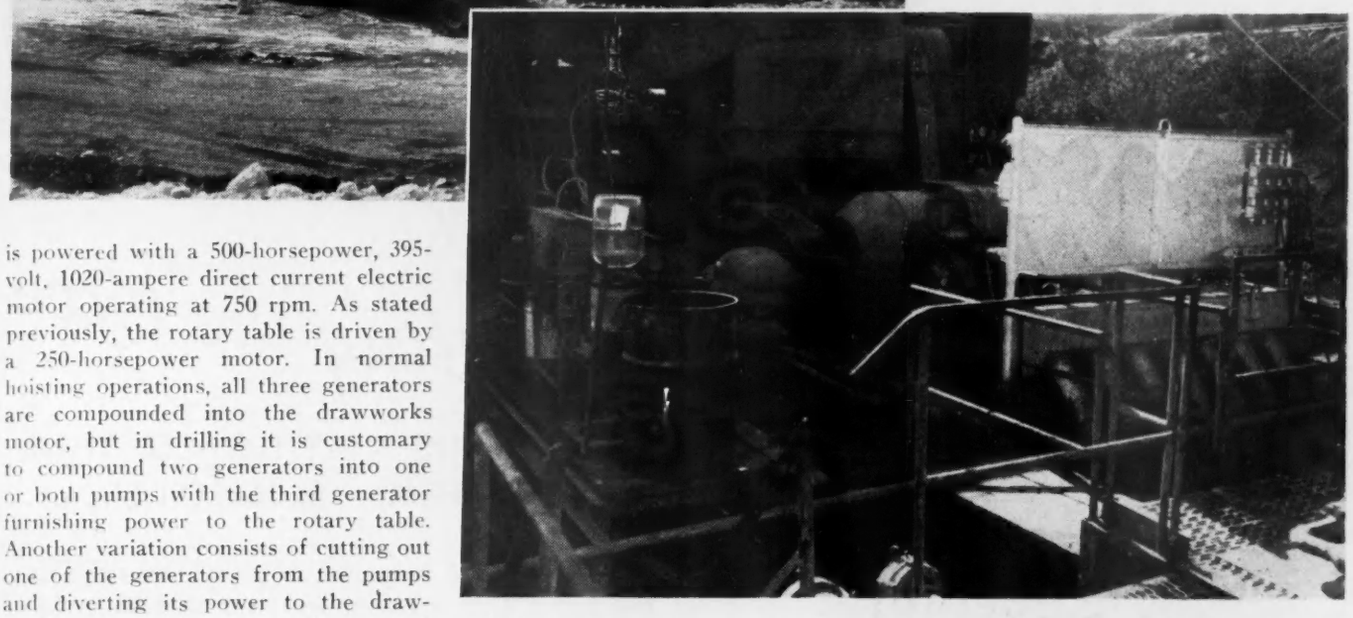
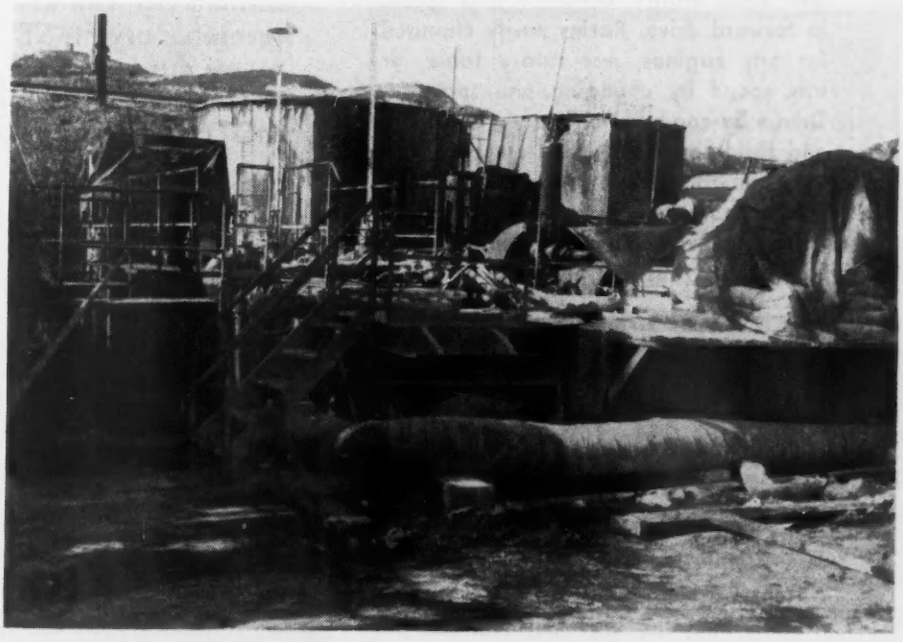


FIGURE 16 (below). Two-compartment mud tank (left) and mud chemical tank (right), both mounted on trailer axles. Note space-conserving method of positioning ends of trailers. Mud connections are ball-jointed to allow some degree of misalignment if necessary. In foreground is 15-inch spiral-ring-supported flexible duct delivering gas-free air to drawworks and rotary table motors.



is powered with a 500-horsepower, 395-volt, 1020-ampere direct current electric motor operating at 750 rpm. As stated previously, the rotary table is driven by a 250-horsepower motor. In normal hoisting operations, all three generators are compounded into the drawworks motor, but in drilling it is customary to compound two generators into one or both pumps with the third generator furnishing power to the rotary table. Another variation consists of cutting out one of the generators from the pumps and diverting its power to the drawworks motor when power is required on the drawworks while drilling. About 45 combinations and variations of this type are possible, all being controlled by the driller at his console. Advantages of this high degree of flexibility are apparent when, for example, one of the engine-generator units has to be shut down for repairs or maintenance, or some accident temporarily takes a unit out of service. It also makes possible the rapid shifting of power to any phase of the drilling operations when for any reason a sudden heavy load occurs.

The method employed for controlling speed and power output of the large electric motors is interesting in that fields can be varied and controlled by the output of a small two-kilowatt exciter. This exciter is controlled by an oil-immersed rheostat beneath the derrick floor. The rheostat is remotely operated from the driller's console by pneumatic linkage. Each of the large motors has three fields, the latter being interconnected in such a way that the output of a motor may be closely controlled without possibility of overloading. If an unusually heavy load occurs, amperage will be increased, but at the same time voltage will progressively drop until the motor slows down or stops, all without danger of stalling the engine driving the generator.

The design of the rig called for the use of direct current motors on all types of continuous duty operations, and altering current motors wherever only part time duty is necessary. Typical functions of the smaller motors used on the rig are the three-horsepower continuous duty motor which drives the vaned hydraulic pump furnishing power to the drawworks hydraulic brakes, and the small motor which drives the pump furnishing power to the throttle controls. Intermittent operation is required of the five-horsepower motors which

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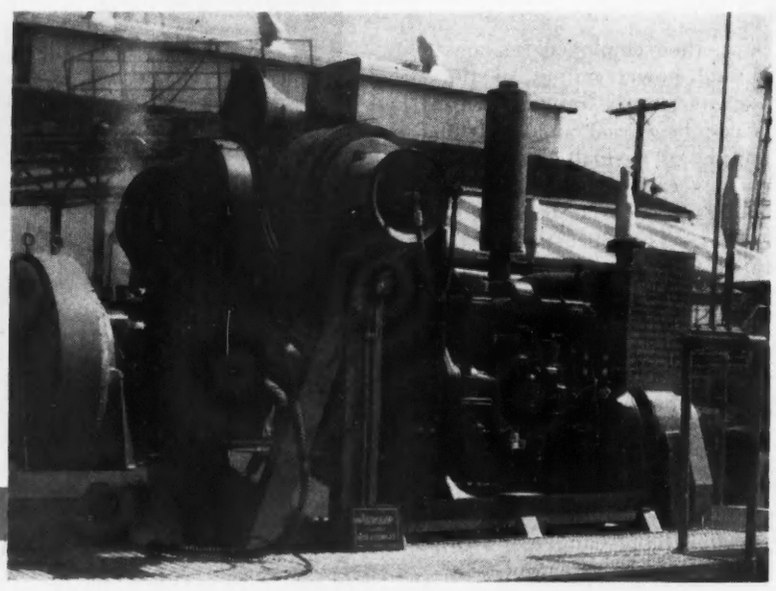

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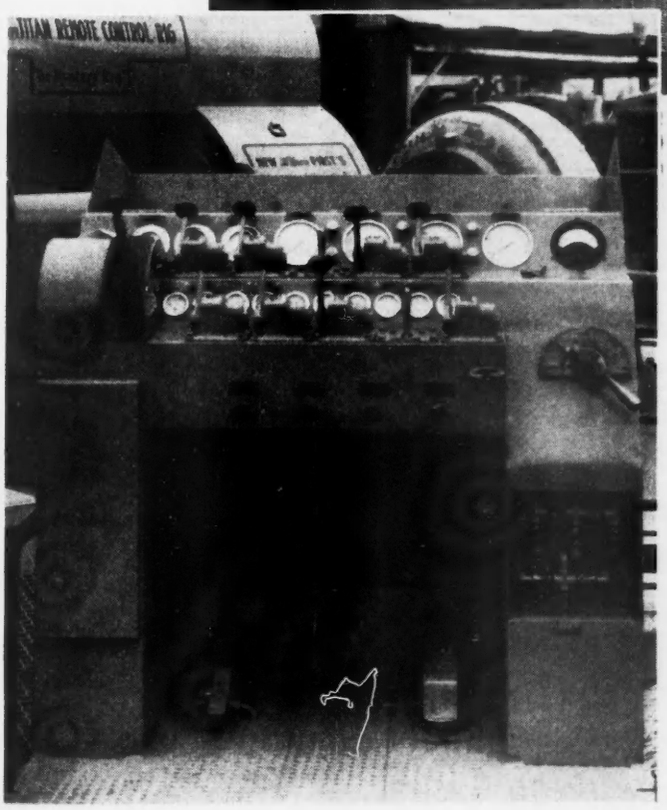

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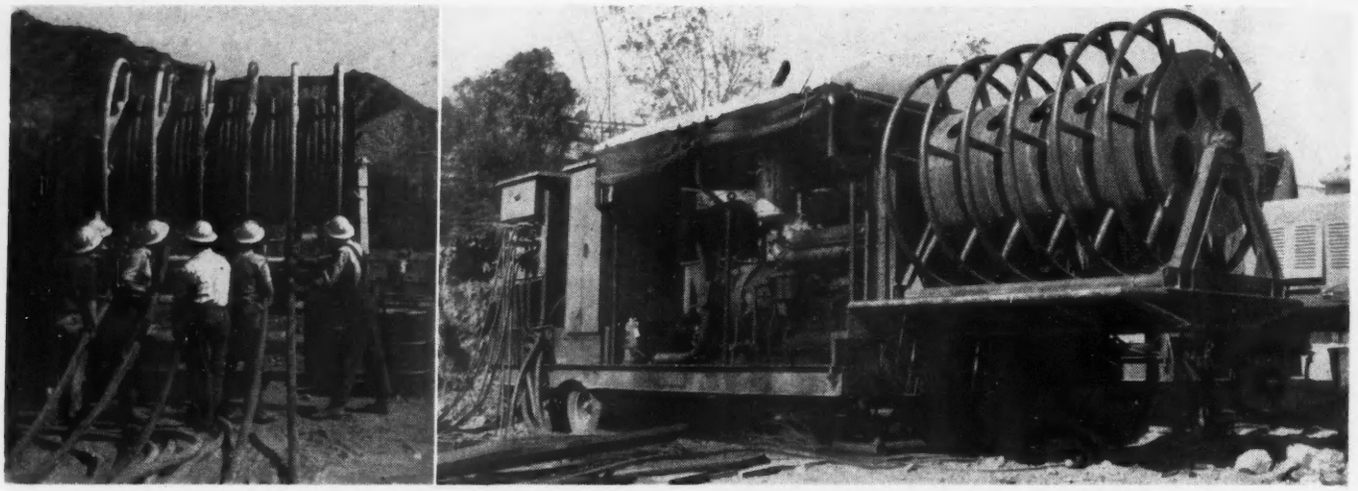


FIGURE 17. One of the two semi-trailers carrying generators and their 12-cylinder gas engine prime movers. Trailer shown carries one of the three 200 kilowatt direct current generators, main control panel, and five-section reel on which are coiled main electric cables when rig is moved. With one man at each cable, all five lines can be spooled in about 30 minutes.

extend the derrick legs and the ten-horsepower motor mounted in the sub-base which drives the hydraulic ram and drill pipe racking pipe chute motors.

Blowers are employed to cool the large motors. An independent blower unit, located at a distance from the derrick, draws in cool, gas-free air through an elevated duct, and delivers it to the drawworks and rotary table motors, these two units being connected in series since it is seldom that both motors will be operated at one time. Gas-free air is maintained at a slight pressure inside the motor cages. The blower motor and air intake duct shown in Figure 18 are built into a unitized package, with air being delivered to the rig in a 15-inch fabric and spiral steel ring duct which can be collapsed for easy hauling between locations. A 23-foot section of this flexible duct will telescope down to a section less than four feet high. Warm air exhausted from this system may be directed to the derrick floor if desired where, on cold days or nights, the crew can derive some degree of comfort from it. Slush pump motors are equipped individually with blowers. Blowers are connected into the main motor switches and go on automatically when a motor is started.

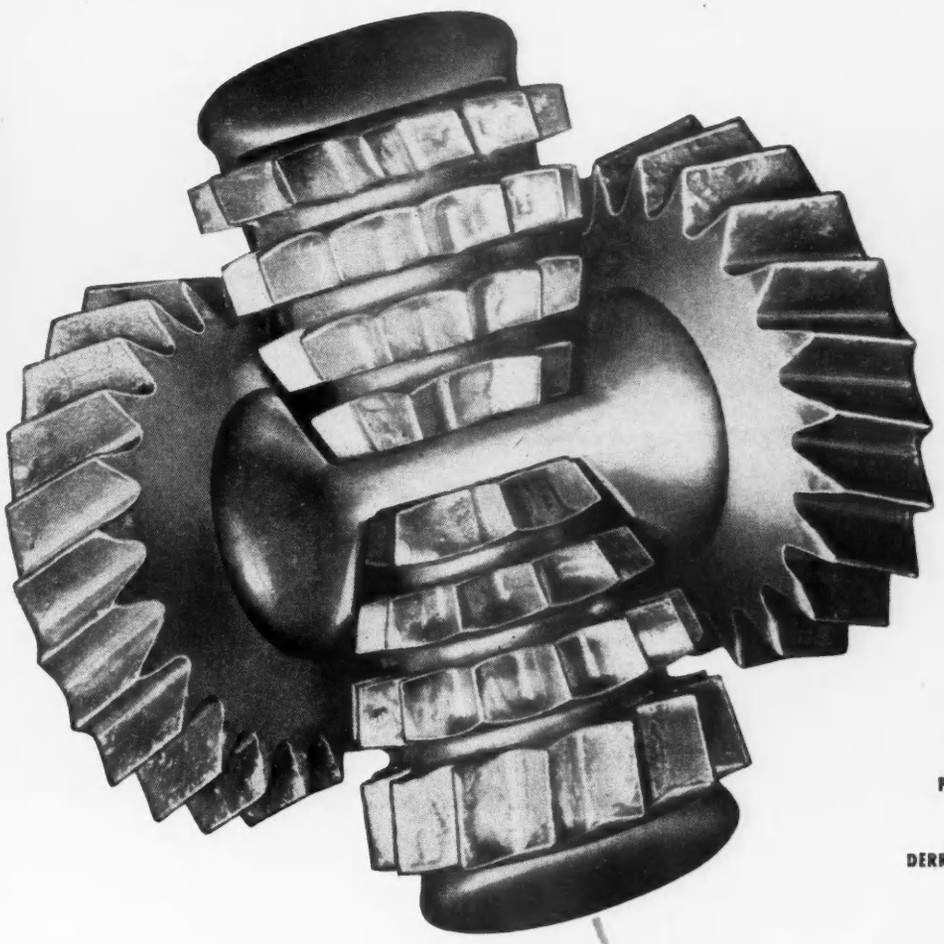
FIGURE 18. Each pump motor is equipped with its own blower unit for cooling and elimination of spark hazards. Blower with elevated intake shown here supplies gas-free air to both drawworks and rotary table motor, the latter two units being connected in series with collapsible duct.

Shadowless Rig Lighting

An unusual feature is that there are no general illumination lights mounted in the derrick. Lighting is furnished by banks of reflector lights hung on the guy lines. Shown in Figure 19, the banks of lights each consisting of four 500-watt flood lights, are so positioned and directed as to provide an evenly distributed shadowless illumination over the derrick floor, pipe racks, platforms and pump area. The lights are strung up with the guy lines. Four 200-watt lights are installed under the derrick floor at strategic points for illumination of that area. Alternating current is used for lighting.

Electronic Control Devices

The drawworks is equipped with a pair of self-equalizing, remote-controlled hydraulic brakes (Figure 19) and an eddy current brake, the latter mounted on the drawworks drum shaft. The wide range of braking control obtained from the latter unit, together with the safety features of air clutches, removes danger of failure or improper adjustment of the hydraulic brakes. A clutch on the eddy current brake permits disengaging the unit when the blocks are



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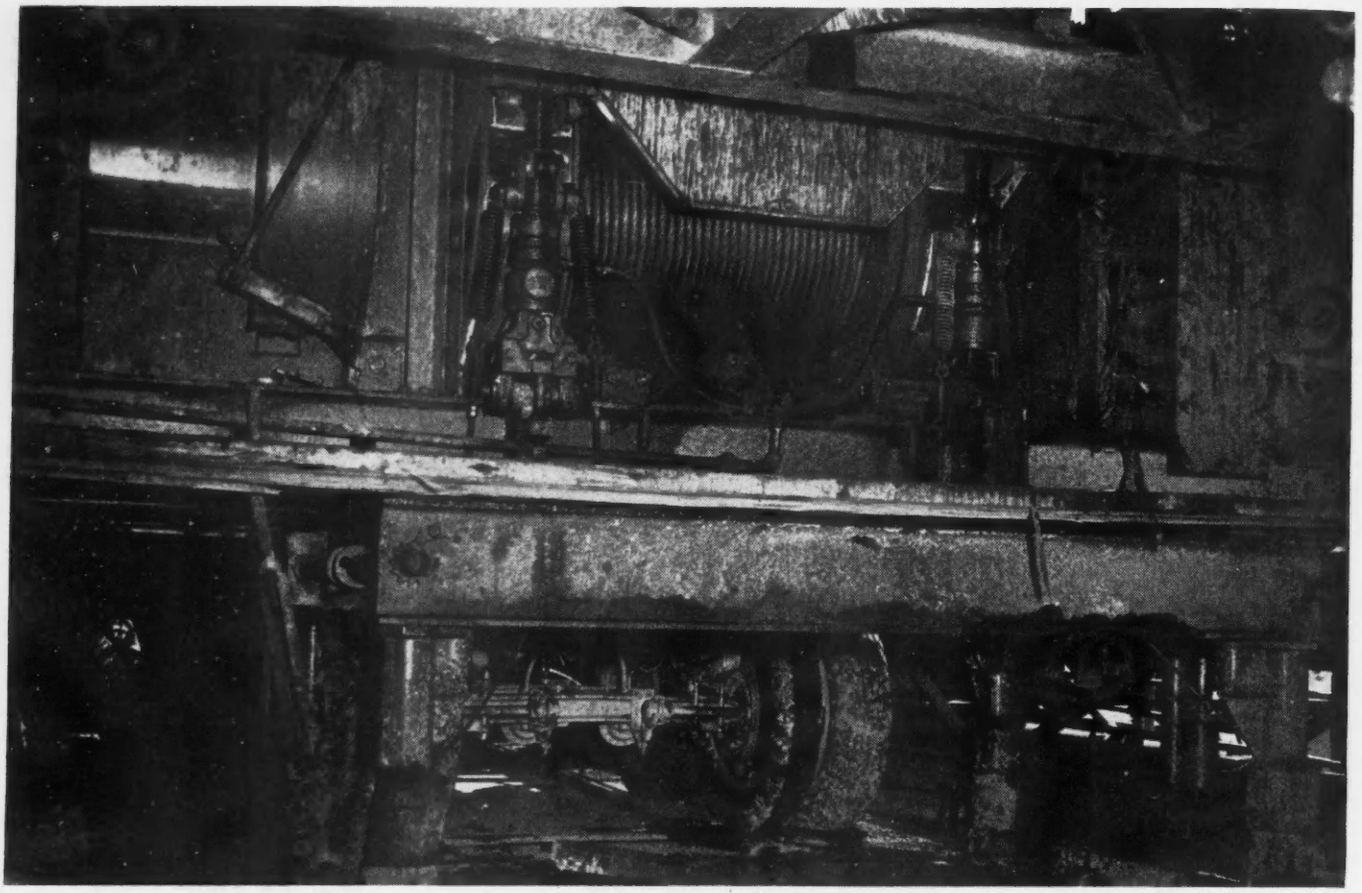


FIGURE 19. Self-equalizing hydraulic brakes and eddy current brake have contributed much to smooth operation of the rig. Hydraulic brakes are visible in foreground; eddy current brake, only partially visible, is at right. Trailer wheels visible are those belonging to unit carrying drawworks motor, transmission and sand line reel.

falling, thus reducing time required for hoisting operations.

To control the rate of penetration and to regulate the weight of the bit on bottom, a second eddy current device is used. This electronic-controlled coupling is on the selective speed transmission trailer. The drive back from the drawworks is through the conventional driving chains and through the electric motor into a 20.4 to 1 gear increaser, which gives an over-all reduction of 1000 to 1 between the drum shaft and dynamatic coupling. The latter is mounted on the output side of the gear increaser, and by controlling the intensity of the current in the coupling, it is possible to control the rate of feed-off or torque on the drum shaft which in turn controls the weight carried on the bit.

An electronic weight indicator device designed to read the block load through an electric strain gauge located in the traveling block clevis also is included in the control equipment. This gauge picks up its indication of weight from the elongation of the gauge, the strain indication being transmitted by cable to an electronic box located near the control panel on the selective speed transmission trailer. A 1000-cycle alternating current full bridge system is used, and voltage can be regulated to within two volts over a range of from 95 to 130 volts. The power to the system is supplied from the 110-115 volt, 250 watt, 50-60 cycle alternating current rig system. The electronic system makes it possible to read the weight indicated on a dial calibrated in equal divisions for all weights. On the indicator used on this rig, a 1/10-inch dial spacing equals a 1-ton hook load. The load indicated by this gauge is independent of the number of lines strung or the size of the line, as it is a direct reading of the hook load.

Reviewing the over-all picture of the method of transporting rig equipment, it is seen that the majority of the pieces is moved by seven pneumatic-tired units. An eighth trailer, although not a functional part of the drilling rig, carries the all-steel change house which contains lockers, heating equipment, telephone, lavatory and chemical toilet. Mobile cranes are employed for handling the telescoped derrick after it is laid down, picking up and placing of derrick bases, racks, etc. This may be compared to the equipment-moving problem of the average steam rig of comparable depth capacity which may require up to 23 truck loads to completely move from one location to another. With the present rig it now requires about four days to tear down and set up ready for spudding-in at the next location. It is expected, however, that this time will be reduced eventually to about 48 hours.

The new rig requires a much smaller and simpler type of concrete base or mat. No cellar is necessary and only a comparatively small concrete pad is required for the rig bases. Before the rig is moved in, a 10¾-inch rathole and a 11¾-inch mousehole are dug, this work being done by a contractor who drills the holes to exact specifications as to depth, pitch and angle to conform with requirements of the drilling equipment.

That the new rig is performing according to the expectations of its designers may be seen in the fact that to date not only have drilling operations speeded up appreciably, but the rig has suffered no major mechanical breakdowns such as twist-offs, broken chains or shafts, or clutch trouble. This success has been attained despite the fact that the entire rig, controls, method of setting up, etc., were new to the crews, and that during the initial drilling jobs a certain amount of "breaking in" of the men on certain operations was necessary before full operating efficiency and speed could be realized. It demonstrates again that with top engineering talent, the cooperation of oil field equipment manufacturers, together with the incentive to do things quicker and at less expense, the oil industry will continue to see outstanding achievements.

Acidizing Rig Water Wells

By M. M. DeWITT
Development Engineer, Dowell Incorporated

IN AREAS where fresh water is insufficient for drilling and other field operations, the problem of obtaining an adequate water supply is solved by the sinking of wells to a shallow water table. Water wells are indispensable in such regions as the Permian Basin, which is almost entirely devoid of springs or streams. In the Guymon-Hugoton gas area of western Kansas and Oklahoma where surface water is scarce, wells are restricted to one per 640 acres and because of such wide spacing each well drilled must depend on its own water well.

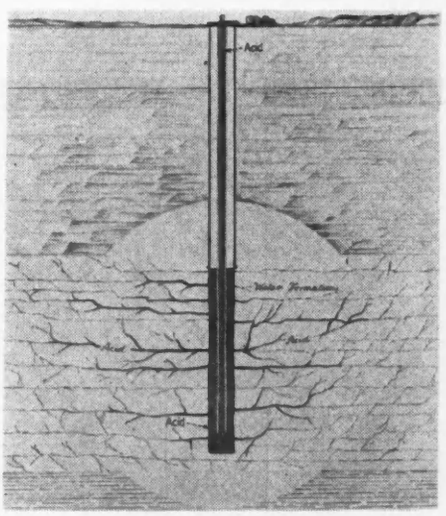
The drilling of a shallow water well presents no problem to the operator who sinks the hole in a matter of days. The real problem, however, and one that frequently plagues the contractor, presents itself when the well fails to produce sufficient water for all needs around the rig. In order to avoid the loss of time and expense involved in drilling a twin well, the operator as a rule can correct the trouble by the simple expedient of acidizing the water-producing horizon. Water wells present specific problems in acidizing, and technique which may be applied successfully to oil and gas-bearing horizons may not have the same salutary effect when applied to a water stratum.

Fortunately, the water well usually does not present a difficult engineering problem in the treatment. It is relatively shallow, its pressures are low, and its producing formations are responsive to proper chemical application. Instead, the difficulties to which it is susceptible make the problem that of the selection of appropriate chemical solvents and treating techniques.

In its passage through the earth, water will dissolve and carry with it some of the minerals with which it comes in contact. As the water flow converges at the well bore, it encounters different pressure conditions and mixes with other formation waters which can cause it to precipitate and deposit some of its mineral content at the face of the formation, the screen, the pump, and other metal equipment. These scale depositions will plug the screen, reduce the pump efficiency, and assist in oxidation and corrosion of the metals. As the waters converge on the well bore, they also carry sand and sediments which may clog the flow channels, restricting the flow of water into the well.

A decrease in production usually is the first indication that one or more of several possible situations exist. In the case of a purely mechanical difficulty, such as the failure of some part of the operating mechanism, the water supply reduction may be quite sudden and the trouble readily apparent. But where the indication of trouble is gradual, such as a steadily increasing drawdown rate, the difficulty may not be of a mechanical nature.

A decrease in the water available for production, caused by a lowering of the water table which determines its natural drive, is always possible. Here it should be remembered that the hydrostatic head of the well does not necessarily represent the level of the water table. Some wells develop circulation within themselves among two or more zones. If internal circulation is suspected, one of the several accepted methods for determining the "thief" zone should be used. A lowering water table may be caused by several factors, such as overproduction and periods of low rainfall. However, a decrease in available water can be due to causes other than a lowering water table, such as restrictions in the formation at the critical area near the well bore or at the screen. This situation is revealed by an increase in drawdown at a given rate of flow and an increase in the time necessary for the well to reach its static level when off production. Where these difficulties exist, the proper application of chemical solvents usually is an efficient and effective remedy.



Acidizing water-bearing formation.

An increase in drawdown, probably the most frequent sign of trouble, may be due to any one or a combination of several situations. Worn parts may be reducing the efficiency of the pump, in which case the corrective measures must be mechanical. However, accumulated scale and corrosion products also can reduce pump efficiency, in which case the most efficient corrective action usually is the application of chemical solvents.

Use of Chemicals for Increasing Production

The basic solvent used is hydrochloric acid containing non-toxic inhibitors, which protect the metal equipment of the well from the action of the acid. This solvent is capable of dissolving and removing most of the scale accumulations or corrosion products which may be encountered. Water-well scales usually consist primarily of calcium and magnesium carbonates, silicates, and hydrated iron oxides. But in the event that unusual compounds or conditions are presented, the properties of the basic solvent may be altered to fit the situation. Additive agents are available to intensify or retard the action of the acid, to decrease its surface tension, and to stabilize it against the re-precipitation of certain compounds which tend to be less soluble with a decrease in the concentration of the acid.

The treating technique is essentially the same on all water wells, even though unique situations may cause some alteration. No complicated hook-up is involved, and the well need not be off production for any extended time. When the pump is located at or near the water-producing zone, all of the solvent may

be introduced through the pump. When the pump is located at a considerable distance above the producing zone, the solvent may be introduced through a hose or pipe, in order that it may be brought into immediate contact with the screen and formation. Where it is desired to force the solvent into the formation, a water flush is used. After a predetermined time interval, the well is placed back on production, the producing waters rapidly clearing the well of all traces of the solvent.

In the instance where the primary object of the treatment is to acidize the producing formation for the purpose of increasing its permeability, it usually is desirable to circulate at least a part of the solvent through the pump. This procedure serves to clean up the impellers, even though no actual difficulty is being experienced where the pump is concerned.

When limestone wells are acidized, the size of the bore hole seldom is increased. What usually happens is that, as the acid is forced back into the formation, the pores and fissures are interconnected and the formation is honeycombed, increasing permeability. When treating limestone formations, it is necessary to use relatively large amounts of acid in order that the formation will be penetrated a considerable distance from the bore hole. Where the formation is almost pure limestone and is of low original permeability, it is sometimes necessary to use retarding agents. These agents are mixed with the inhibited acid and have the effect of slowing down the rate of reaction without affecting the amount of formation that can be dissolved. The use of retarding agents allows the acid to be pumped far back into the formation before it becomes spent. Other chemicals, such as wetting, foaming, and penetrating agents, also are used on certain types of limestone formations. An important consideration which is frequently overlooked is the choice of the correct acid concentration. If the concentration is too low, sufficient reaction does not take place; while, on the other hand, if the concentration is too high, the viscosity of the spent solvent can be so high that difficulty is experienced in returning the acid from the formation to the bore hole.

Although the problems of sandstone well treating are much the same as those of limestone wells, the technique is somewhat different. Sandstone formations as a rule consist of quartz or a siliceous compound which is cemented with a calcareous material. In these formations, usually all that is necessary to increase permeability is to remove the cementing medium. Large volumes of relatively weak acid are used on wells of this type since the ratio of soluble material is low. However, there are some locations where the percentage of calcareous material is very low, and in these formations there must be an actual removal of some of the siliceous formation in order to increase the permeability. As in the case of limestone wells, the bore hole is not necessarily enlarged, but rather increased production is obtained by opening the formation. For these siliceous formations there are additive agents available which may be combined with hydrochloric acid so that actual reaction with the formation can be accomplished and its permeability increased by opening or creating veins.

Removal of Used Solutions

The handling of limestone and sandstone wells for removing spent solution and insoluble material oftentimes differs. In the case of limestone wells, the formation usually will clean itself by returning the well to normal production methods, since the purging of the spent solvent is assisted by carbon dioxide created in the formation through the reaction of the acid and the limestone. Sandstone wells, however, sometimes require assistance by "surging" the formation. This "surging" may consist of alternately producing the well and injecting water down the bore hole. The forward and reverse flow of the water usually will flush out the insoluble material loosened by the acid, enabling it to be carried from the formation into the well.

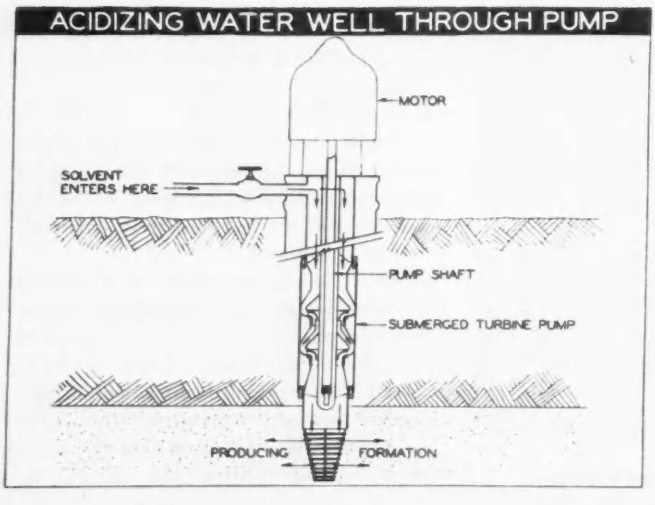
A third classification of water producing formation is the type which goes under various names such as chert, conglomerate, or gravel. Usually the problem is only to remove some of the cementing material and thus to loosen the formation.

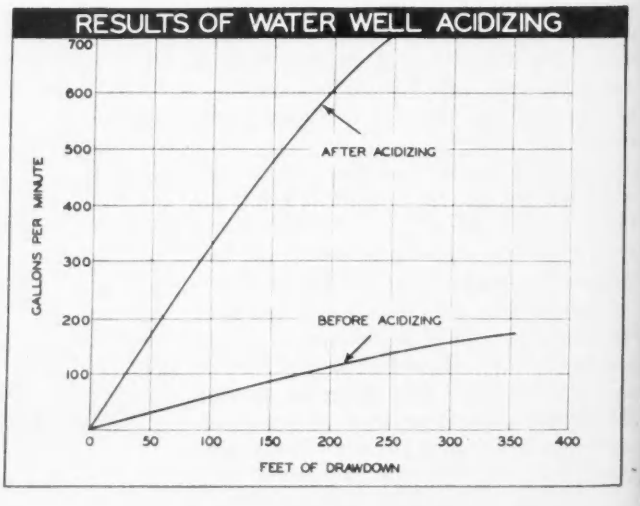
Other Treating Considerations

Most of the foregoing discussion has dealt with increasing well production through the use of acid on soluble formations. But, in a large percentage of treatments, the acid is never intended to enter the formation. Instead, the treatment is designed to clean the well equipment. Pump efficiency and capacity decline due to scale incrustations changing the contour of the impellers, plugging the ports, and creating friction within the flow. All of these ills can be corrected without the necessity of pulling the pump, through the proper use of acid solvents. Here caution should be observed. The pump is usually operated while the solvent is in the hole, therefore it must be determined whether the acid inhibitor affords protection to metals at high velocity. Furthermore, the limitations imposed on inhibitors for water-well use by taste, odor, and toxicity requirements narrow the choice to an extremely small field.

Through the use of chemicals most water-well pumping equipment can be cleaned in about four hours. Screens and gravel packs, which cause considerable trouble in some areas, also can be cleared in a rasonable time.

The results of the average water-well chemical treatment oftentimes exceed the operator's expectations. It is not an unusual instance for a well to produce more water than when first drilled, or to produce at full pump capacity with little apparent drawdown, following the proper chemical treatment.





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Diamond Coring An Oklahoma Well

By R. M. SWESNIK

THE USE of diamond core-heads is achieving wider application in the Mid-Continent area, especially in critical wells where an accurate evaluation of formations is necessary. In a well in Oklahoma diamond coring established a possible world record for amount of core cut in an individual well. The diamond core-head obtains a high recovery and, under certain conditions, is said to cut hole more economically than conventional bits.

THE diamond coring operation of Anderson-Prichard Oil Corporation at Chipman 1, NW SW NE 11-1s-2E, Murray County, was perhaps the most unique method of drilling a well thus far attempted in Oklahoma. The well was cored almost continuously from the base of the Woodford shale to the Oil Creek formation of lower Simpson age, where it was abandoned.

The Mid-Continent's, if not the world's, record was set for the amount of core cut on an individual well with diamond core-heads, as well as the record for the total footage cut with one diamond bit.

This well was cored in the belief that the coring could be done more cheaply than actual drilling. One of the reasons for this belief was the splendid coring records set in the Lindsay pools in Garvin County during recent months. In contrast Sinclair Prairie Oil Company's Lancaster Trust 1, approximately 1¼ miles westward from Chipman 1, encountered extremely hard formations, and during 14 months intermittent drilling required an excessive number of rotary and cable tool bits to complete the hole. Drilling alternately with cable tool and rotary methods was necessary because the formations were so difficult to penetrate. Experience in the Sinclair test suggested the use of the diamond coring method of drilling in drilling Chipman 1.

The coring done on this test was done with ordinary water base mud, and is one of several reasons this was considered an unusual venture.

Coring Begun

Coring was begun at 1870 feet, where a 10-foot core was taken to check the equipment and familiarize all personnel with the operation of the barrel. Continuous coring was started at 2373 feet in the base of the Woodford shale and continued to 2723 feet in the Sylvan shale. The Sylvan was encountered at 2696 feet and was cored for 27 feet before drilling was resumed. After coring to 2473 feet, seven-inch casing was set at 2442 feet to prevent possible trouble from caving Pontotoc conglomerate and Caney shales.

Coring was again begun in the base of the Sylvan at 2855 feet and continued to 3588 feet, where it was necessary to drill up broken bearings which fell in the hole. The hole was drilled to 3650 feet, where coring was resumed and continued to 3875 feet. Again some broken bearings which fell into the hole had to be drilled up. Coring was initiated once more at 3945 feet and continued to 4015 feet. After drilling the interval 4015-62 feet, coring was again continued to 4066 feet. The lower portion of this core was very soft slick shale which had a tendency to block the barrel, and it was decided to drill ahead. When abandonment orders were given, a last core was taken from 4254 to 4271 feet to have a better check on the formations in the bottom of the hole.

The total footage cored amounted to 1403 feet, of which 1167 feet were recovered, or 83.2 percent. Tabulated data showing cores cut, bit records and coring time are shown in Table 1. Bit R-9352 cored 746 feet, 4 inches and recovered a total of 653 feet, 7 inches, or 87.9 percent. In the first 616 feet, 4 inches, cored, 612 feet, 9 inches were recovered for an amazing recovery of 99.5 percent.

One interesting aspect of the footage made by this bit from 2856 to 2929 feet is that this interval consisted of alternate bands of chert and semi-dense hard limestone with conchoidal fracture. The drillers and drilling superintendents estimated that it would require at least 50 rock bits to have cut this 73 feet, although this was only a small portion of the 746 feet total cut by this one diamond core-head. After cutting this particular 73 feet, the head was not noticeably worn or damaged in any way.

In coring this test well a split string of drill pipe was used, consisting of 3½-inch and 2⅞-inch drill pipe, because

About the Author

R. M. SWESNIK is district geologist in Southern Oklahoma for Anderson-Prichard Oil Corporation at Oklahoma City, with whom he has been associated since April, 1946. A graduate of University of Oklahoma in 1938, he has worked with Kingwood Oil Company, Tex Harvey Oil Company, and Sun Oil Company. Following his discharge from the Army he returned to Oklahoma University for his master of science degree, during which work he was employed part-time by Gulf Oil Corporation. He continued his graduate studies while working for the Oklahoma Geologic Survey, making a subsurface tectonic map of the state. His contributions to Oklahoma geology include his thesis and papers on the West Edmond and Southwest Antioch pools and stratigraphic convergence problems.

not enough 3½-inch was available. Fifteen 3½-inch drill collars were also used so that the drill collars were kept in compression while the rest of the string was held in tension, helping to eliminate crooked hole trouble. The use of the split string made "rough-necking" particularly difficult, for it was necessary to change elevators, tong heads and slips seven times during each round trip, once for the 3½-inch drill pipe, then for the 2⅞-inch drill pipe, then for the 3½-inch drill collars, and finally for the 4-inch core barrel. In addition to that, rough-necking was further complicated by the left-hand threads on the inner tube of the core barrels. These left-hand threads "ate up" even the seasoned hands.

In using this core barrel it was found by experience that at least the bottom and sometimes both top and bottom bearings had to be changed after each core, otherwise there was danger of the bearings breaking and junk falling into the hole, thereby ruining the diamond head. The optimum conditions for coring with a diamond head are achieved when an even weight is carried on the bit. Due to mechanical difficulties, optimum conditions were never attained. Nevertheless, core recoveries and long bit life were realized on this test.

Showing method of extracting core from barrel. Clamps catch core as barrel is raised. Long, unbroken sections of core often necessitated breaking into smaller pieces for convenient handling.

Some of the disadvantages of drilling with a diamond head include its inability to recover highly fractured formations or soft shales. In the case of highly fractured formations with steep dips, a fragment may become lodged part way up the barrel, thereby plugging it and preventing any more core from entering. The barrel rides on the top bearing, causing damage, and if too much weight is used, the barrel is kinked. Shales cut at a much slower rate than they can be drilled, and the soft, sticky varieties have a tendency to plug the barrel. However, short cores of soft shale and fractured beds can be cut. Another disadvantage is the sensitivity of the diamond head to any junk in the hole. Even such small things as a cotter pin injure the bit and make it unusable. A chunk of pyrite approximately three inches in diameter, which fell into the hole from the wall of the formation, was responsible for ruining a core-head. One other disadvantage is that core-heads are not yet available in many of the sizes in which rock bits can be obtained. When going from the smaller to medium or large size heads, it is necessary to have three different sizes of core barrels.

The advantages of diamond coring over ordinary drilling in extremely hard formations are numerous. The saving on rock bits and rig time are the greatest advantages from an economical view-

TABLE 1

Anderson-Prichard Oil Corporation's Chipman 1, NW NW SW NE Sec. 11-1s-2e, Murray County, Oklahoma

Bit No.	Core No.	CORED From	CORED To	FEET CORED Footage Cut	FEET CORED Total	Footage Rec.	Percent Rec.	Total Footage Rec.	Percent Total Rec.	Coring Time Minutes	Weight on Bit Lbs.	Rotary Table Speed RPM	Mud Viscosity Seconds	Mud Weight Lbs./Gal.	Mud Water Loss cc/100 psi /30M	Pump Pressure Lbs.
WR-378	0	1870	1880	10	10	4	40	4	40	307	10,000	90	38	9.7	10	175
	1	2373	2378	5	15	5	100	9	60	155	10,000	90	36	9.6	10	175
	2	2378	2403	25	40	15	60	24	60	670	10,000	90	40	9.7	10	175
	3	2403	2414	11	51	11	100	35	68.7	344	10,000	90	37	9.6	9	175
	4	2414	2425	11	62	11	100	46	74.3	281	12,000	90	38	9.6	9.2	175
	5	2425	2430′ 8″	5′ 8″	67′ 8″	5′ 8″	100	51′ 8″	76.4	128	12,000	95	38	9.6	9.2	175
R-9352	6	2430′ 8″	2449	18′ 4″	86	18	97.1	69′ 8″	81	254	12,000	45	35	9.5	9.5	175
	7	2448	2473	25	111	25	100	94′ 8″	85.3	584	12,000	50	34	9.3	10	175
	8	2473	2509	36	147	36	100	130′ 8″	88.9	962	12,000	60	36	9.3	10	175
	9	2509	2541	32	179	32	100	162′ 8″	90.8	986	12,000	70	36	9.3	10	175
	10	2541	2586	45	224	45	100	207′ 8″	92.6	1159	10,000	90	38	9.5	10	150
	11	2586	2632	46	270	46	100	253′ 8″	93.9	1295	10,000	90	39	9.3	7.2	150
	12	2632	2678	46	316	46	100	299′ 8″	94.7	1436	10,000	90	39	9.4	7.2	150
	13	2678	2700	22	338	22	100	321′ 8″	95.2	613	8,000	80	38	9.3	8	150
	14	2700	2717	17	355	17	100	338′ 8″	95.5	457	8,000	80	40	9.4	8	225
	15	2717	2723	6	361	6	100	344′ 8″	95.5	295	8,000	80	40	9.3	8	175
	16	2855	2899	44	405	44	100	388′ 8″	96	1245	8,000	80	40	9.3	9	175
	17	2899	2945	46	451	46	100	434′ 8″	96.4	1350	8,000	90	39	9.3	9.6	150
	18	2945	2977′ 6″	32′ 6″	483′ 6″	32′ 6″	100	467′ 2″	96.7	1075	8,000	90	39	9.3	9.6	150
	19	2977′ 6″	2991	13′ 6″	497	13′ 6″	100	480′ 8″	96.8	397	8,000	90	41	9.3	9.6	150
	20	2991	3040	49	546	47	95.9	527′ 8″	96.7	1580	8,000	90	40	9.4	7.2	150
	21	3040	3081′ 9″	41′ 9″	587′ 9″	41′ 9″	100	569′ 5″	96.8	1267	8,000	90	41	9.2	7.2	150
	22	3081′ 9″	3108′ 9″	27	614′ 9″	27	100	596′ 5″	97.3	580	8,000	90	38	9.3	7.2	175
	23	3108′ 9″	3140	31′ 3″	646	29	93	625′ 5″	96.8	473	8,000	90	43	9.4	7.2	175
	24	3140	3178	38	684	37	97.4	662′ 5″	96.9	1027	9,000	90	43	9.5	9.4	175
WR-376	25	3178	3205	27	711	24	88.8	686′ 5″	96.6	350	9,000	90	43	9.5	9.3	175
R-9352	26	3205	3247	42	753	25	59.5	711′ 5″	94.5	451	9,000	90	43	10	9.3	175
	27	3247	3295	48	801	12	25	723′ 5″	90.2	363	9,000	90	44	10	9.3	150
	28	3295	3335	40	841	3′ 10″	7.93	727′ 3″	86.4	317	9,000	90	52	9.5	9.3	175
WR-376	29	3335	3364′ 6″	29′ 6″	870′ 6″	8	27.1	735′ 3″	84.4	192	10,000	120	52	9.3	9.3	175
R-9353	30	3364′ 6″	3377	12′ 6″	883	12′ 6″	100	747′ 9″	84.7	56	9,000	90	52	10	9.6	175
	31	3377	3412	35	918	16	45.7	763′ 9″	83.3	190	9,000	90	52	9.9	9.6	150
	32	3412	3443	31	949	29′ 6″	95.1	793′ 3″	83.6	630	10,000	90	41	9.9	9.6	150
	33	3443	3479	36	985	34	94.4	827′ 3″	84.1	492	10,000	90	50	10	9.6	175
	34	3479	3506	27	1012	22	81.5	849′ 3″	83.7	182	10,000	90	50	9.9	9.3	175
	35	3506	3540	34	1046	19′ 6″	57.3	868′ 9″	83.1	301	9,000	90	48	10	9.6	175
WR 376	36	3540	3588	48	1094	18′ 3″	38	887	81.1	1013	10,000	90	42	9.9	8.6	175
	37	3650	3655′ 4″	5′ 4″	1099′ 4″	5′ 4″	100	892′ 4″	81.3	69	9,000	90	44	9.9	9.6	175
	38	3655′ 9″	3672′ 8″	17′ 4″	1116′ 8″	17′ 4″	100	909′ 8″	81.5	327	9,000	90	45	9.9	9.6	175
	39	3672′ 8″	3689	16′ 4″	1133	16′ 4″	100	926	81.9	339	9,000	90	46	9.9	9.6	175
	40	3696	3715′ 8″	19′ 8″	1152′ 8″	18	91.7	944	81.8	550	9,000	90	47	9.9	8.6	175
	41	3715′ 8″	3753	37′ 4″	1190	37′ 4″	100	981′ 4″	82.4	793	9,000	90	46	9.9	8.6	175
	42	3753	3781	28	1218	26′ 3″	93.8	1007′ 7″	82.7	547	9,000	90	42	9.8	8.6	150
	43	3781	3826	45	1263	45	100	1052′ 7″	83.5	1474	9,000	90	48	9.8	10	150
	44	3826	3875	49	1312	31	63.3	1083′ 7″	82.7	945	9,000	90	46	10	10	175
WR-467	45	3945	3984	39	1351	39	100	1122′ 7″	83.0	1249	9,000	90	44	9.9	10	175
	46	3984	4015	31	1382	24	77.4	1146′ 7″	82.8	806	9,000	90	46	10	8.4	175
	47	4062	4066	4	1386	3′ 6″	88.6	1150′ 1″	83.0	135	9,000	90	50	10	8.4	175
	48	4254	4271	17	1403	17	100	1167′ 1″	83.2	280	8,000	90	44	9.9	8.6	150

point. The principal advantages of diamond coring over ordinary coring operations are the ability to core 50 feet without making a trip and the excellent recoveries, affording almost complete knowledge of formations encountered. It is predicted that diamond coring will revolutionize the drilling of hard formations and add much to the general knowledge of stratigraphy of the areas in which it is used.

It is estimated that the aggregate cores from the Chipman well weighed approximately 15,000 pounds or 7½ tons. They were placed in 403 three-foot long core boxes and presented to the University of Oklahoma for further study with the request that they be put on display for 30 days for interested members of the oil industry.

A detailed core description is appended, showing the type of material which was cut with the diamond coreheads.

ANDERSON-PRICHARD OIL CORPORATION
CHIPMAN 1, NW NW SW NE Sec. 11-1S-2E
Murray County, Oklahoma
Core Descriptions

Core 1—2373 to 2378—155 Minutes—Cut 5', Recovered 5' (100%) 5' bright green, slightly silty, flaky shale, excellent cleavage along bedding planes; thin, dark brown to brown-black, medium-textured shale interbedded throughout. Brown shale contains sporangites and occasional conodonts; small crystals of pyrite scattered throughout, some large nodules up to 6mm by 4mm.

Core 2—2378 to 2403—670 Minutes—Cut 25', Recovered 15' (60%) 15' bright green, fine-textured, fissile shale with few scattered pyrite crystals. Cleaves along bedding planes at approximately 35°.

Core 3—2403 to 2414—344 Minutes—Cut 11', Recovered 11' (100%). 11' bright green, finely textured homogeneous fissile shale with small pyrite crystals scattered throughout. Dip 20° to 30°.

Core 4—2414 to 2425—281 Minutes—Cut 11', Recovered 11' (100%). 5.4' alternating bands (.1'-.3') dark brown and bright green shale as above; .2' shale breccia, green matrix with brown and green shale pebbles and pyrite; resembles fault gouge; 5.4' alternating bands of dark brown and bright green shale as above with brown predominating at base. Dip approximately 20°.

Core 5—2425 to 2430'8"—128 Minutes—Cut 5'8", Recovered 5'8" (100%). 4'7" dark brown fine-textured shale with wafer-thin streaks of light brown shale and occasional pyrite nodules; .9' light gray to light green, finely crystalline, finely sucrose, slightly flaky limestone with wafer-thin streaks of oil-stained dolomite; .1' dark brown, very finely crystalline, very cherty dolomite with vertical fractures containing stain of heavy oil.

Core 6—2430'8" to 2449—254 Minutes—Cut 18'4", Recovered 18' (97.1%). .4' dark brown, very finely crystalline cherty dolomite with vugs and fractures up to .5mm wide, saturated with heavy oil; bleeding oil and gas when fresh; .7' light gray to green, coarsely crystalline, fragmental, fossiliferous, limestone with fractures saturated with heavy oil; .6' dark brown, finely crystalline, sucrose, slightly fossiliferous, porous dolomite. Sparse vertical fractures, highly saturated with heavy oil and gas; 1.6' light gray (brown where saturated), fine to coarse, crystalline, very fossiliferous, slightly porous (small vugs), dolomitic limestone; 1' light gray to buff, coarsely crystalline, fragmental limestone, many crinoid stem segments. Many thin fractures refilled with green argillaceous material, some fractures saturated with heavy oil; .7' light green to gray, very finely crystalline, finely sucrose, slightly fossiliferous limestone; 8' light gray with greenish cast, coarsely crystalline limestone; many vertical fractures refilled with green argillaceous material; few stylolites. Core breaks at approximately 20° at green shale partings; 1.3' light green to gray, finely crystalline, finely sucrose, flaky limestone, with crinoid stem segments and occasional fossils; 4' light gray, coarsely crystalline limestone with many refilled fractures and few stylolites.

SLC: 2449 = 2448. Core 7—2448 to 2473—584 Minutes—Cut 25', Recovered 25' (100%). 6' light gray with greenish cast, coarsely crystalline, fragmental, fossiliferous, fractured, slightly glauconitic limestone, breaks along thin green shale laminae; 12' light gray to buff, finely crystalline, flaky, sucrose limestone, very glauconitic at or near horizontal fractures; many refilled horizontal fractures up to 2mm to 3mm wide. Very fossiliferous in few spots and coquina-like 1' from bottom, coarsely crystalline, light gray limestone and finely crystalline dolomite, saturated with heavy oil; 1.1' light gray to buff, coarsely crystalline, fragmental limestone; .4' dark brown, finely crystalline, sucrose dolomite, to dolomitic limestone very heavily saturated; 3.8' light gray to buff, coarsely crystalline limestone with minor fractures and few streaks of saturated dolomite; .2' white to light gray, very finely crystalline to cryptocrystalline, fractured cherty limestone; 1.5' brown, finely crystalline, sucrose, fossiliferous

Photograph by University of Oklahoma.

Part of cores as displayed at the University of Oklahoma. The sample sack contains unconsolidated Bromide sand which was well saturated. White marker on top of box in center of picture gives result of drill-stem test of the interval.

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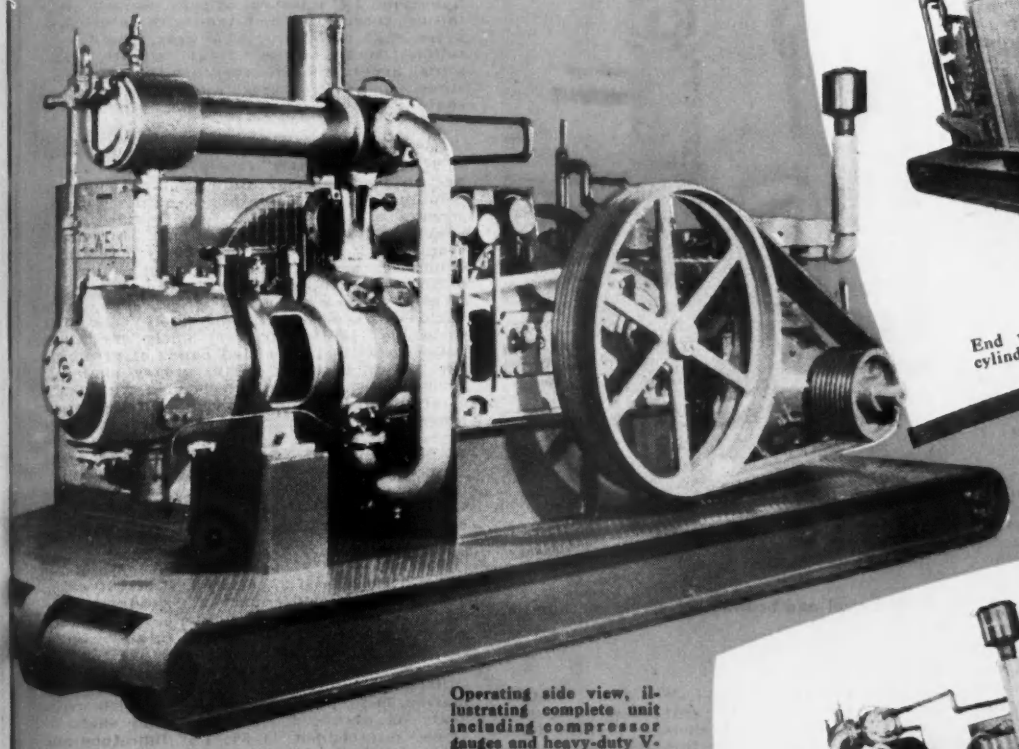
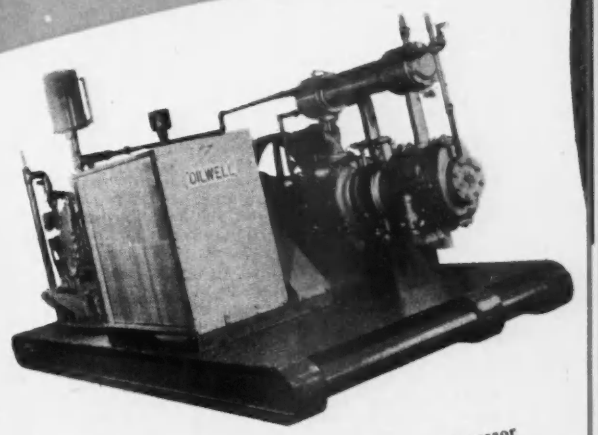
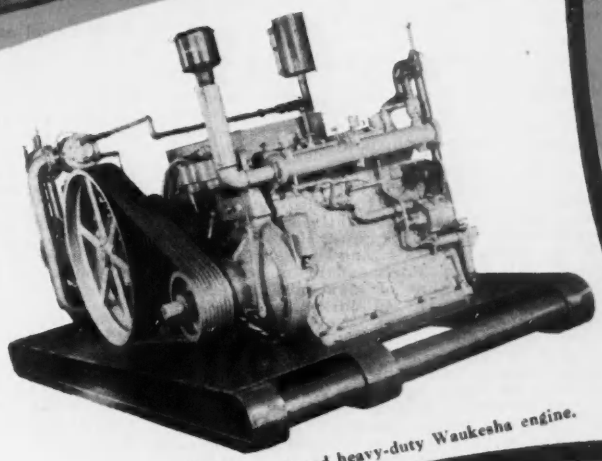


Operating side view, illustrating complete unit including compressor gauges and heavy-duty V-belt drive of the "Oilwell" 2-stage Gas-Booster Unit.



End view illustrating the unit cooler, compressor cylinders with top mounted inter-cooler for dry gas.



Power-end view illustrating specially equipped heavy-duty Waukesha engine.

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dolomite with heavy oil saturation. Dolomite has banded, cross-bedded appearance and is interbedded with streaks up to .3' wide of light gray, very finely crystalline limestone and buff, coarsely crystalline fragmental limestone.

Core 8—2473 to 2509—962 Minutes—Cut 36', Recovered 36' (100%). 8' brown, finely crystalline, sucrose fossiliferous dolomite with heavy oil saturation. Dolomite has banded, cross-bedded appearance, interbedded with thin streaks of light gray, finely crystalline limestone and buff coarsely crystalline, fragmental limestone; 28' light gray-buff to green-gray, finely crystalline, sucrose, slightly dolomitic fossiliferous, slightly argillaceous limestone; ½' from top .2' very dolomitic with heavy oil saturation. Contains some minor fractures and thin streaks of dark brown, finely crystalline, sucrose dolomite.

Core 9—2509 to 2541—986 Minutes—Cut 32', Recovered 32' (100%). 32' light gray, finely crystalline, sucrose, flaky limestone with few streaks of very argillaceous, finely crystalline limestone.

Core 10—2541 to 2586—1159 Minutes—Cut 45', Recovered 45' (100%). 3' medium-gray, finely crystalline, finely sucrose, flaky, slightly dolomitic, argillaceous, fossiliferous limestone; 6' light gray, finely crystalline, sucrose, flaky, fossiliferous limestone; 3' medium-gray, finely crystalline, finely sucrose, flaky, slightly dolomitic and argillaceous, fossiliferous limestone; 3' light gray, finely crystalline, sucrose, flaky, fossiliferous limestone; 30' medium to dark gray, finely crystalline, finely sucrose, flaky, slightly dolomitic and argillaceous, fossiliferous limestone with occasional pyrite crystals, mottled, banded appearance where more argillaceous. No measurable dip.

Core 11—2586 to 2632—1295 Minutes—Cut 46', Recovered 46' (100%). 46' medium to dark gray, finely crystalline, slightly sucrose, flaky, argillaceous, fossiliferous limestone with few pyrite crystals, few fractures at top. Fractures 19' to 23' from top refilled with coarsely crystalline fragmental limestone.

Core 12—2632 to 2678—1436 Minutes—Cut 46', Recovered 46' (100%). 46' medium to dark gray finely crystalline, slightly sucrose, flaky, argillaceous, fossiliferous limestone with sparse pyrite crystals and rare fractures; some wafer-thin laminae of shale.

Core 13—2678 to 2700—613 Minutes—Cut 22', Recovered 22' (100%). 12.8' medium to dark gray, finely crystalline, slightly sucrose, flaky, argillaceous, fossiliferous limestone with sparse pyrite crystals and occasional fractures; .1' green limey shale matrix, four coarse, round grains of glauconite; .1' green slick shale; 5' light to dark gray, coarsely crystalline, fragmental, fractured, slightly glauconitic, pink crinoidal limestone with streaks of light green fine shale and darker gray, coarsely crystalline limestone filling fissures. Core dolomitized in part with slight vuggy porosity, bleeding oil; .2' light green to gray, very finely crystalline, slightly flaky, argillaceous limestone with large amount of pyrite. Breaks at approximately 25°. 3.8' light green to gray very finely crystalline, flaky, very argillaceous limestone with small perfect cubes of pyrite abundantly scattered throughout.

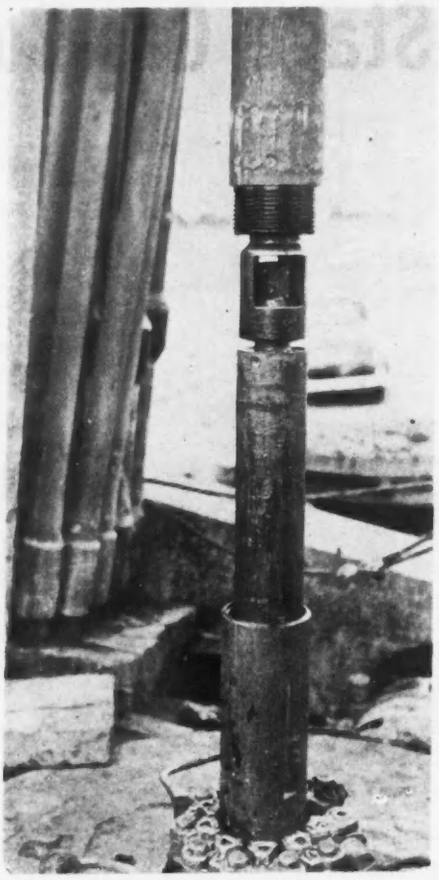
Core 14—2700 to 2717—457 Minutes—Cut 17', Recovered 17' (100%). 17' bright green, fine, splintery, fissile, very calcareous Sylvan shale with few scattered pyrite grains. Breaks at 25° dip.

Core 15—2717 to 2723—295 Minutes—Cut 6', Recovered 6' (100%). 6' bright green, very calcareous, fine, splintery, very fissile Sylvan shale with sparse pyrite crystals; 25° to 35° dip.

(Drilled 2723 to 2855)

Core 16—2855 to 2899—1245 Minutes—Cut 44', Recovered 44' (100%). 1.4' bright green, very fine, flaky, highly shattered and fractured pyritic Sylvan shale, possible graptolites; 42.6' alternating bands varying from .1' to .5' in width, brown very finely crystalline dense, semi-lithographic, hard limestone with conchoidal fracture and dark brown siliceous dolomite and chert. Entire core very fractured, some fractures having been filled with clear calcite veins. Bands show small faults of 1mm. displacement. Dip approximately 25°, some heavy oil in fractures, good odor on break in limestone.

Core 17—2899 to 2945—1350 Minutes—Cut



Inner barrel and bearings of coring mechanism.

46', Recovered 46' (100%). 30' same as bottom 42.6' of Core #16; 16' gray, fine to coarse, crystalline, fragmental, sucrose, slightly dolomitic, very fossiliferous limestone with mottled appearance due to many irregular thin streaks of green, finely crystalline, very argillaceous limestone to limey shale. Some pinpoint bleedings of oil and gas in fractures of high gravity oil with low gravity oil in few fractures.

Core 18—2945 to 2977'6"—1075 Minutes—Cut 32'6", Recovered 32'6" (100%). 3' gray to buff, coarsely crystalline, fragmental, fossiliferous, fractured, argillaceous limestone; 13' gray to buff, coarsely crystalline, fragmental, very fossiliferous, dolomitic limestone with very heavy oil saturation bottom 7'; 16.5' gray to buff, coarsely crystalline, fragmental, fossiliferous, argillaceous, slightly dolomitic limestone. More argillaceous toward base with what appears to be fault breccia, highly fractured.

Core 19—2977'6" to 2991—397 Minutes—Cut 13'6", Recovered 13'6" (100%). 7' gray to buff, coarsely crystalline, fragmental, fossiliferous, argillaceous slightly dolomitic limestone; 6' gray, greasy, slick, fissile clay shale; .5' limestone as above.

Core 20—2991 to 3040—1580 Minutes—Cut 49', Recovered 47' (95.9%). 7' gray, coarsely crystalline, fragmental limestone, interbedded with green, greasy, slick, fissile clay shale (50% lime); 2' green, greasy, slick, fissile clay shale, interbedded with very slight amount of limestone; 1.5' interbedded gray coarsely crystalline, fragmental limestone with 50 per cent green shale as above; 36.5' gray, finely crystalline, finely sucrose, flaky, slightly dolomitic, argillaceous to very argillaceous limestone, many fractures refilled with green shale. Basal 6' stained with heavy oil.

Core 21—3040 to 3081'9"—1267 Minutes—Cut 41'9", Recovered 41'9" (100%). 6' gray to buff, fine to medium crystalline, sucrose, slightly dolomitic, sandy limestone with irregular streaks of green shale, few fractures with heavy oil, (sand grains fine to coarse, rounded); 5' buff to brown, finely crystalline, dolomitic, argillaceous limestone; 4' brown, hard, dense, flaky, dolomitic limestone with 1" sandy streak at base; 7' green, slick, fissile shale with few streaks of finely crystalline limestone; 10' brown, very finely crystalline dolomite with interbedded bands of green fissile shale; 1' green, slick, greasy shale; 5' green shale as above, interbedded with finely crystalline to medium crystalline, fossiliferous limestone (50-50); 2' gray to brown, finely crystalline, sucrose, very sandy dolomite, sand grains medium-coarse, rounded; 1'9" brown to gray-brown, finely crystalline, dense dolomitic limestone with occasional crystals of clear calcite, fractures at base saturated with heavy oil.

Core 22—3081'9" to 3108'9"—580 Minutes—Cut 27', Recovered 27' (100%). 6' bright green, fine, fissile, fossiliferous and sandy (coarse round sand grains) clay shale, interbedded with gray, finely crystalline, sucrose, flaky, fossiliferous, slightly sandy limestone (50-50); 6' gray, finely crystalline, sucrose, flaky, fossiliferous, slightly sandy limestone, approximately 20-25 percent interbedded with green shale as above; 3' limestone and shale as above, interbedded, 50-50; 1'6" limestone and shale as above, with 75-80 percent limestone and 20-25 percent shale; 7'6" coarse-grained, loosely calcareously cemented to no cementation at all, rounded sandstone, very highly saturated; 3' green to gray finely crystalline, flaky sucrose, slightly dolomitic, fossiliferous, argillaceous limestone with small fault displacements.

Core 23—3108'9" to 3140—473 Minutes—Cut 31'3", Recovered 29' (93%). 6' green to gray, finely crystalline, sucrose, flaky ,argillaceous, slightly dolomitic limestone with fault displacements; 2'6" bright green, slick, sandy clay shale; 12' clear, coarse-grained, soft, calcareously cemented to no cementation, round, highly saturated sandstone; 2' bright green, slick, sandy clay shale; 6' sandstone as above;

Entire core of well boxed for shipment. There are 5½ stacks with 72 three-foot boxes in each stack. Weight computed at approximately 7½ tons.

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1′ white, hard, tight, calcareously cemented, coarse-grained, rounded sandstone; 1′ green, very sandy shale.

Core 24—3140 to 3178—1027 Minutes—Cut 38′, Recovered 37′ (97.4%). 3′ green-gray, finely crystalline, fossiliferous, argillaceous limestone; 2′ green, hard, slick, calcareous shale; 19′ green to gray, finely crystalline, fossiliferous, argillaceous limestone interbedded with green, slick, calcareous shale; 2′ green, hard, slick, calcareous shale; 5′ brown, medium to fine-grained, angular to sub-angular, very argillaceous and calcareous sandstone with oil stain; 6′ gray to green, finely crystalline, fossiliferous, argillaceous and arenaceous limestone, fractured, and fractures refilled with green shale.

Core 25—3178 to 3205—350 Minutes—Cut 27′, Recovered 24′ (88.8%). 1′ green, fissile, slick shale, interbedded with green to gray, finely crystalline limestone; 2′ brown, medium, sub-rounded, non-porous, very argillaceous sandstone to sandy shale; 3′ brown, clear, medium-grained, sub-rounded, porous and permeable, calcareously cemented, oil-saturated sandstone; .5′ clear, medium to fine-grained, sub-rounded, very argillaceous, calcareously cemented sandstone to sandy shale; 4′ brown, oil-saturated, clear, clean, medium-grained, rounded, porous and permeable sandstone; 1′ bright green, fissile, slick, slightly sandy, blocky shale; 2.5′ brown, clean, medium-grained, rounded, porous and permeable, oil-saturated, calcareously cemented sandstone; 1′ sandstone as above, very argillaceous; 7′ brown, clean, medium-grained, rounded, porous and permeable, oil-saturated, calcareously cemented sandstone; 2′ bright green, hard, very fissile, slick shale with streaks of calcareous tight sandstone, interbedded throughout.

Core 26—3205 to 3247—451 Minutes—Cut 42′, Recovered 25′ (59.5%). 7′ clean, medium-grained, oil-saturated sandstone, varying from porous to non-porous where calcareously cemented. Somewhat argillaceous; 1′ green, slick, fissile, very sandy shale; 17′ clean, medium-grained, oil-saturated sandstone, varying from porous and permeable to non-porous where calcareously cemented.

Core 27—3247 to 3295—363 Minutes—Cut 48′, Recovered 12′ (25%). 12′ clear, brown, oil-stained, fine grained, rounded, porous and permeable, calcareously cemented, slightly argillaceous sandstone, in spots very tightly calcareously cemented, causing wide impermeable streaks scattered throughout.

Core 28—3295 to 3335—317 Minutes—Cut 40′, Recovered 3′10″ (7.93%). 3′10″ clear, fine to medium-grained, brown, oil-stained, calcareously cemented sandstone with white streaks where tightly calcareously cemented.

Core 29—3335 to 3364′6″—192 Minutes—Cut 29′6″, Recovered 8′ (27.1%). 1′ clear, fine-grained, brown, oil-stained, calcareous, rounded sandstone with white spots where tightly calcareously cemented; 3″ green slick shale; 2′6″ sandstone as above; 3″ clear, clean, fine-grained, rounded, black, oil-saturated sandstone; 1′9″ white, hard, tightly calcareously cemented, rounded, fine-grained sandstone, sandstone with thin streaks of porous asphaltic sandstone, approximately 30° dip; 9″ clear, clean, rounded, brown oil-stained, fine-grained, porous and permeable sandstone; 1′6″ clear, brown oil-stained, fine-grained, rounded sandstone, calcareously cemented in spots, interbedded with green shale throughout.

Core 30—3364′6″ to 3377—56 Minutes—Cut 12′6″, Recovered 12′6″ (100%). 1.6′ clear, medium grained, sub-rounded, slightly calcareous sandstone with small scattered green shale inclusions, light oil stain and odor; .3′ white, medium-grained, sub-rounded, very calcareous hard sandstone; 10.2′ clear, medium-grained, sub-rounded, slightly calcareous sandstone with small green shale inclusions and occasional wafer-thin shale laminae, light stain and odor; .4′ white, medium-grained, sub-rounded, very calcareous hard sandstone.

Core 31—3377 to 3412—190 Minutes—Cut 35′, Recovered 16′ (45.7%). 1′ green, slightly sandy calcareous shale; 8.4′ clear, medium-grained, sub-rounded, calcareous, porous and permeable saturated sandstone; 4.8′ green, very sandy, calcareous shale to very argillaceous, medium to fine-grained, calcareous sandstone; 1.8′ light gray to green, mottled, argillaceous, very sandy, finely crystalline limestone. No measurable dip.

Core 32—3412 to 3443—630 Minutes—Cut 31′, Recovered 29′6″ (95.1%). 4′ green calcareous, sandy shale, interbedded with fine-grained sandy, finely crystalline gray limestone, approximately 15° dip; 16.3′ light gray finely crystalline, very sandy (fine angular grains) grading to dark green, very finely crystalline, flaky limestone; 3′ dark green, very fissile, blocky, sandy, calcareous shale; 3.3′ dark gray to brown, finely crystalline, sandy, flaky limestone with light oil stain; .5′ dark green, very fissile, blocky, sandy, calcareous shale; .8′ light gray, very sandy and argillaceous, finely crystalline limestone; 1.6′ dark gray, very fissile, blocky, sandy calcareous shale.

Core 33—3443 to 3479—492 Minutes—Cut 36′, Recovered 34′ (94.4%). 3′ dark green, fine, blocky, fissile, slightly pyritic, slightly calcareous shale with .5′ sandy green calcareous streak 6″ from top, approximately 20° dip; 23′ gray, finely crystalline, argillaceous limestone with bottom 1′ very sandy (calcareous sandstone), occasional thin streaks of sandy shale; thin streaks of sand saturated with heavy oil, slightly fractured; 8′ clear, brown, oil-saturated calcareous, porous and permeable, soft sandstone with occasional streaks of hard, tightly calcareously cemented sandstone.

Core 34—3479 to 3506—182 Minutes—Cut 27′, Recovered 22′ (81.5%). 19′ clear, brown, oil-stained, medium-grained, sub-rounded, porous and permeable, calcareous sandstone with occasional shale inclusions and laminae, occasional streaks of hard, impervious white, calcareously cemented sand; 1′ hard, white, tight, very calcareous sandstone; .5′ green, very sandy, calcareous shale; 1.5′ clear, brown, oil-saturated, medium-grained, sub-rounded, calcareous sandstone.

Core 35—3506 to 3540—301 Minutes—Cut 34′, Recovered 19′6″ (57.3%). 3′8″ clear, brown, oil-saturated, medium-grained, calcareous sandstone with streaks of tight hard, white, calcareously cemented sandstone with few thin shale laminae; 2′ green, fissile, blocky, very sandy, (oil-saturated) shale; shale and sand laminae alternating and approximately ½″ thick; 3′10″ clear, brown to black, oil-saturated, medium to fine-grained, sub-rounded, loose sand with no cementing material; some occasional streaks of hard white, calcareous, impervious sandstone.

Core 36—3540 to 3588—1013 Minutes—Cut 48′, Recovered 18′3″ (38%). 17′ clear, light brown, oil-stained, fine-grained, sub-rounded to sub-angular, porous, calcareously cemented sandstone, alternating with bands of hard, tight, white, very calcareous, fine-grained, sub-rounded to sub-angular sandstone; 1′ sandstone banded as above, with very heavy oil saturation; .2′ green, very calcareous, fossiliferous shale, interbedded with finely crystalline gray limestone.

(Drilled 3588 to 3650)

Core 37—3650 to 3655′4″—69 Minutes—Cut 5′4″, Recovered 5′4″ (100%). 5′1″ gray to buff, coarse to very coarse, crystalline, fragmental, porous limestone with finely crystalline, sucrose, brown, heavily oil-saturated dolomite in pore space of coarse crystalline limestone above. Core bled heavy oil and gas.

Core 38—3655′4″ to 3672′8″—327 Minutes—Cut 17′4″, Recovered 17′4″ (100%). 10′ gray to buff, coarse to very coarse crystalline, fragmental limestone with finely crystalline, sucrose, brown, oil-saturated dolomite in pore space. Core not saturated except for dolomite; 1′ gray, finely crystalline, oolitic, slightly fossiliferous limestone with three stylolites; 6′1″ gray to buff, coarse crystalline limestone matrix for medium-sized oolites, many stylolites, spotted saturation throughout.

Core 39—3672′8″ to 3689—339 Minutes—Cut 16′4″, Recovered 16′4″ (100%). 7′ gray to buff, coarse crystalline limestone matrix for medium-fine oolites, many stylolites, spotted saturation; 2′4″ gray to buff, coarse crystalline, fragmental limestone, grading to, and interbedded with, finely crystalline dolomite, slightly argillaceous and fossiliferous, somewhat sandy in top 6″, heavily spotted oil saturation; 7′ bright green, fine, flaky, very calcareous, slightly fossiliferous shale with pebbles of limestone throughout (pebbles approximately 1 to 4mm.). Limestone is coarse crystalline, buff, and fossiliferous, approximately 30-50 percent limestone to shale.

SLC: 3689 = 3696. Core 40—3696 to 3715′8″—550 Minutes—Cut 19′8″, Recovered 18′ (91.7%). 18′ bright green, fine, flaky, fissile, very calcareous, slightly fossiliferous shale with pebbles of limestone throughout. Limestone is buff, coarse to finely crystalline; grades from pebbles to interbedded laminae, approximately 30 to 50 percent limestone.

Core 41—3715′8″ to 3753—793 Minutes—Cut 37′4″, Recovered 37′4″ (100%). 30′ bright green, very calcareous, fossiliferous shale, interbedded with fine to medium crystalline, fossiliferous limestone; 7′4″ clear, brown, oil-saturated, porous and permeable sandstone, grading to green, non-porous, non-saturated, argillaceous and calcareous, medium to fine-grained, sub-rounded sandstone.

Core 42—3753 to 3781—547 Minutes—Cut 28′, Recovered 26′3″ (93.8%). 1′ clear, medium-grained, rounded, very argillaceous and calcareous sandstone; 3′ green, calcareous shale, interbedded with coarse crystalline, fossiliferous very sandy limestone; 4′ clear, fine to medium-grained, rounded, very calcareous and argillaceous sandstone, porosity in fractures and along bedding planes; very heavily saturated and bleeding in top 1′ and bottom 1′, approximately 20° dip; 4.2′ white to green, clear, non-porous, very calcareous, fine-grained rounded sandstone, interbedded with green shale and coarse crystalline limestone. No odor or saturation; 13′ green, fine, very calcareous and sandy fossiliferous shale with interbedded streaks of coarse crystalline, fossiliferous limestone; 1′ bright green, fissile, fine, slick shale.

Core 43—3781 to 3826—1474 Minutes—Cut 45′, Recovered 45′ (100%). 7′ green, calcareous, slightly fossiliferous shale, interbedded with gray, finely crystalline, fossiliferous limestone, 50 percent shale—50 percent limestone; 14′ light gray, very finely crystalline, semidense, slightly argillaceous limestone; core banded where streaks of more argillaceous material occur; 20° dip; 3′ limestone as above, interbedded with green, fine calcareous shale; 18′ light gray, very finely crystalline, semidense, slightly argillaceous limestone, banded where streaks of more argillaceous material occur, approximately 20° dip; 3′ gray to buff, coarse crystalline, fragmental, fossiliferous limestone with occasional green shale laminae.

Core 44—3826 to 3875—945 Minutes—Cut 49′, Recovered 31′ (63.3%). 6′ gray to buff, coarsely crystalline, fragmental, fossiliferous limestone with few shale laminae, small fault offsets; 7′ buff to gray, coarse to finely crystalline, fragmental, fossiliferous, very argillaceous limestone, interbedded with green shale, approximately 30 percent; 18′ clear, coarse to fine-grained, poorly sorted, rounded sandstone, very argillaceous in places, and calcareous; saturated irregularly, varying from heavy saturation to no stain; in general, fairly porous.

(Drilled 3875 to 3945)

Core 45—3945 to 3984—1249 Minutes—Cut 39′, Recovered 39′ (100%). 39′ green, fine, slightly fossiliferous, very calcareous shale with occasional thin laminae of coarse crystalline limestone; 1′ below top, 2″ streak of inter-formational limestone conglomerate.

Core 46—2984 to 4015—806 Minutes—Cut 31′, Recovered 24′ (77.4%). .5′ green, fine, fissile, calcareous shale with very fine calcite crystals throughout; .8′ dark gray, coarsely crystalline, fragmental, very fossiliferous limestone with many ostracods; 3.7′ green, fine, calcareous, fossiliferous shale with few thin streaks of coarsely crystalline, fossiliferous limestone; 1′ gray, fine to coarse, crystalline, fossiliferous limestone; .2′ green calcareous shale; 2.8′ green, very calcareous, highly fossiliferous shale, some parts primarily bryozoa fragments in shale matrix with few other fossils, may be described as bryozoan coquina cemented with shale; 2′ gray to green, finely crystalline, argillaceous limestone with green shale breaks; 13′ gray, coarsely crystalline, fragmental, fossiliferous limestone with ocasional stylolites filled with green shale.

(Drilled 4015 to 4062)

Core 47—4062 to 4066—135 Minutes—Cut 4′, Recovered 3′6″ (88.6%). 2.5′ gray, coarse to very coarse, crystalline, fragmental, slightly fossiliferous limestone with thin shale laminae and few stylolites; 1′ green, slick, very soft shale.

(Drilled 4066 to 4254)

Core 48—4254 to 4271—280 Minutes—Cut 17′, Recovered 17′ (100%). 17′ gray, very coarse, crystalline, fossiliferous limestone with soft green shale partings throughout, spaced approximately 1 to 1½′ apart; upper 8′ fractured and bleeding heavy oil and gas.

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DRILLING HINTS

How to do it!

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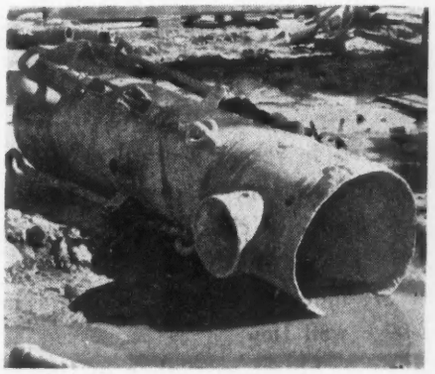
HOW TO—Construct Unitized Drilling Riser to Reduce Installation Costs

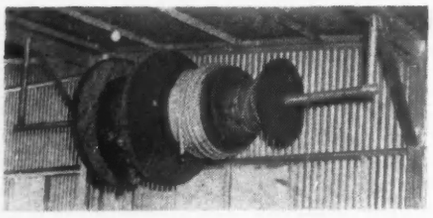
Drilling time is lost and installation costs increased when the conductor pipe must be fitted with mud flow outlet nipple and, later, upon setting of the surface string, the riser must be cut out and removed from the cellar. One drilling contractor has eliminated much of this procedure by building a unitized riser which is installed over and removed from the well in only a fraction of the time formerly required for such operations.

The riser is a seven-foot length of 20-inch pipe, fitted with a sealing ring on bottom, and fitted with four 1⅜-inch turnbuckles evenly spaced around the side. Near the upper end of the riser is welded a short mud return flow nipple of 10¾-inch pipe. Close to the bottom of the unit is welded a heavy ring or flange of one-inch plate. This flange rests upon the slightly raised lip of the conductor pipe cemented in the bottom of the cellar, a rubber gasket being inserted between the two to give a positive leak-proof seal. Following this, the turnbuckles are hooked into heavy eyes anchored in the cellar floor and drawn down tightly.



Removal of the unit is simple. Not only is time saved through use of this device, but welder's service formerly required for cutting off conductor pipe is dispensed with, and hard-to-obtain conductor pipe is conserved by realizing 100 percent salvage of the riser at each location.

HOW TO—Store Spare Cordage to Avoid Damage



Storage of spare cordage around the rig can result in serious damage to the fibers of the rope unless the material is protected against moisture and abrasion. Failure to safeguard on these two points often results in premature service failure, or even in loss of line before it is ever applied to the job.

One company not only protects its spare line but also simplifies the checking of quantities by suspending the reels under the roof of the power section of the rig. Two inverted posts of 2½-inch pipe are welded to adjacent roof beams above the work bench. Tees on the lower ends of the drop legs are bored out so that a length of 2½-inch pipe can be slipped through them, this pipe serving as axle for the reels placed on it before the pipe is set into the supports.

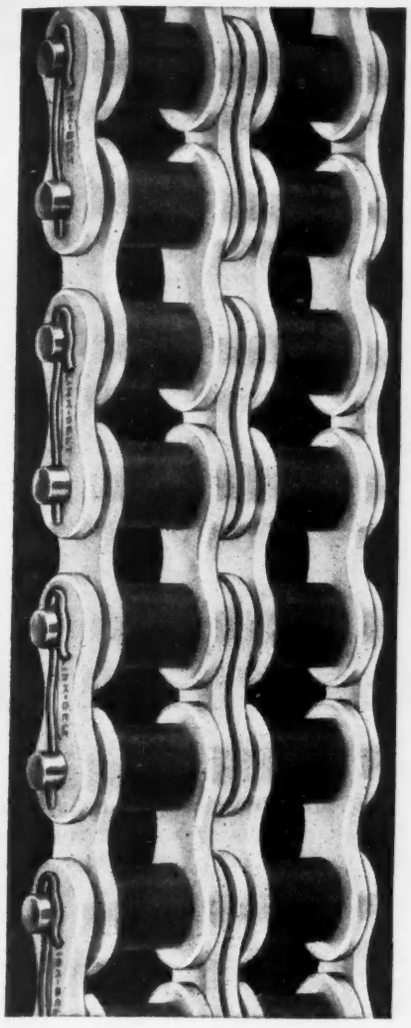
Reels on this rack not only provide storage for new lines, but also provide a place where wornout pieces of rope can be coiled, to be unreeled and cut off whenever marline or twine is required around the rig.

The horizontal pipe may be supported on jacks or by chain hoists hooked into the upper ends of the drop legs, whenever a reel change is required.

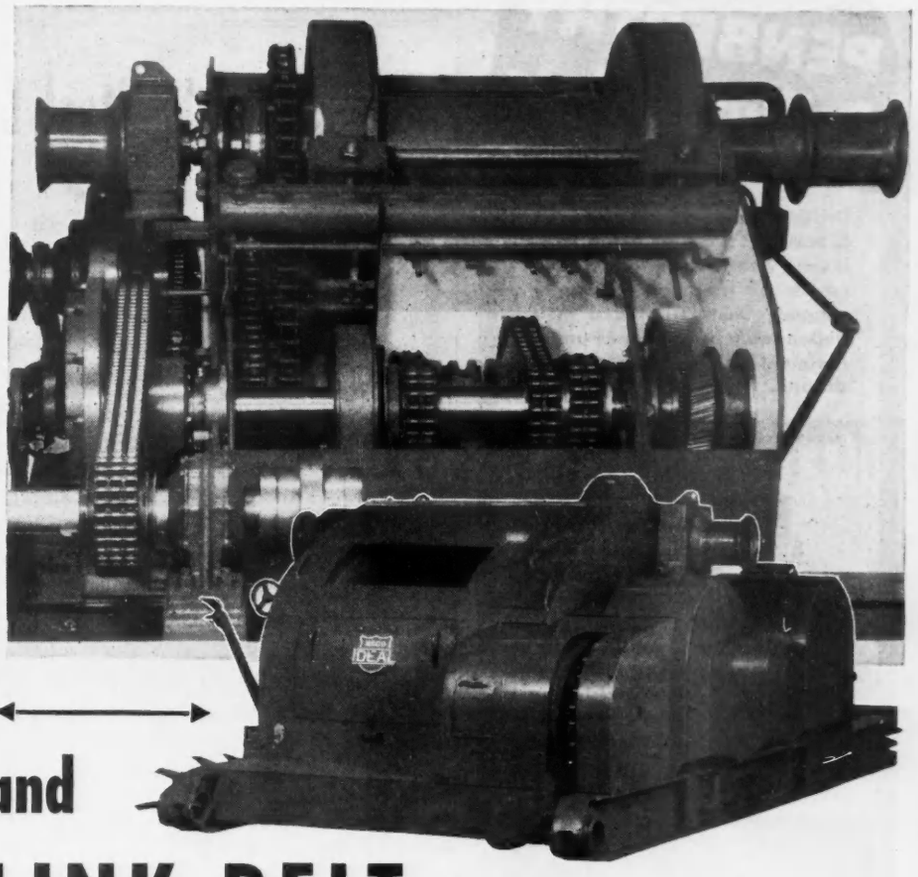
HOW TO—Control Grease Thrown from Roller Guide

The guide roller mounted on the side of the drawworks housing to turn back the wire line before it can run against the facing of the drum prolongs the life of the wire line, but sometimes makes working at the driller's stand not only difficult but dirty. When the line is swabbed with lubricant some of the material adheres to the face of the guide roller and then, as the roll is rotated rapidly when the line is payed out, the grease is thrown off by tangential force.

One driller controls the direction in which the grease is thrown by forming a curved shield from sheet metal, slipping one edge under the roller base and clamping it there by pulling down on the bolts holding the guide in place. The portion of the shield extending upward is curved to fit over the portion of the guide which does not come in contact with the wire line. When so positioned, the guide intercepts the grease which otherwise would travel toward the driller's stand. As the grease guard does not extend out past the end of the guide roller far enough to interfere with observation of the spooling of the line, it does not affect line control.



This rig manufacturer says:
"Constructed for fast, economical drilling"



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You'll find Link-Belt Silverlink 1¾" pitch double roller chain on the transmission drives—Link-Belt Silverlink 2½" pitch single roller chain for drum, catshaft and rotary drives—Link-Belt Silverlink 1¼" pitch triple roller chain for the engine to drawworks drive.

Since trouble-free rig performance in the field hinges largely on dependable power transmission, National has standardized on Link-Belt Silverlink Roller Chain for the Type 50 rig. You'll find dependable Link-Belt chain on all other types of National rigs, too.

In fact, throughout the oil industry, Link-Belt Silverlink Roller Chain is more than ever the choice of the oil country . . . with manufacturer and operator alike . . . because Silverlink continues to set the pace in all kinds of service for dependability, long life and trouble-free service.

> E-Z-ASSEMBLY <

Link-Belt Engineers have developed a construction that makes assembly and disassembly of multiple width chains in the field much easier. The press fits between chain pins and center sidebars have been eliminated, but load distribution across the width of the chain has been maintained.

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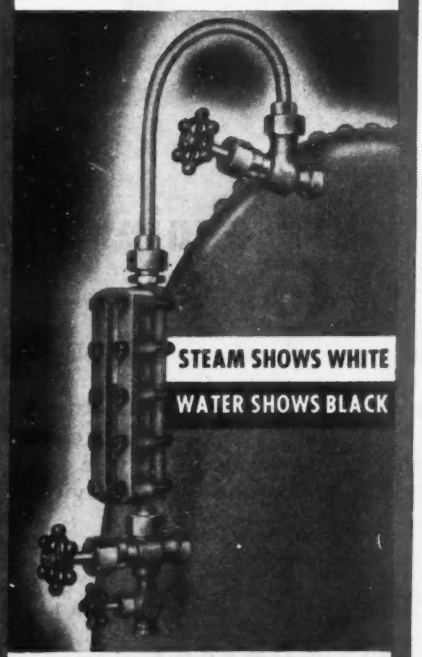

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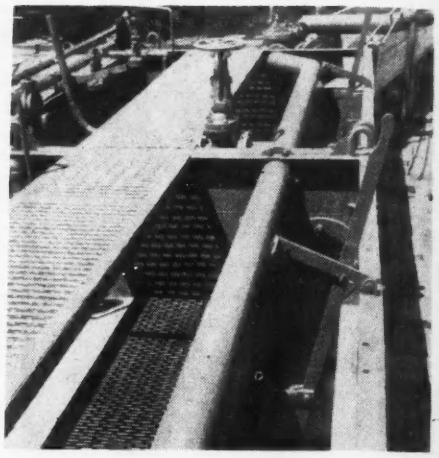
HOW TO—Build Steel Disc Gate in Mud Tank

A steel disc which slides along steel pins welded to the side of the compartment forms the simple blind employed in one installation for admitting or closing off flow of mud from one compartment to another. The blind seats against a matching plate welded to the partition and is operated by a long-handled lever, the fulcrum of which is secured to one of the guide pins. The length of the operating handle provides ample leverage for opening or closing the gate when a high head of heavy mud exists on either side of the opening. Attached to the side of the tank is a hinged locking device consisting of a short length of flat steel bar containing two notches, the latter being engaged by a pin welded to the side of the handle. The device securely holds the handle in either the full open or tightly closed positions but



is easily released and changed when necessary.

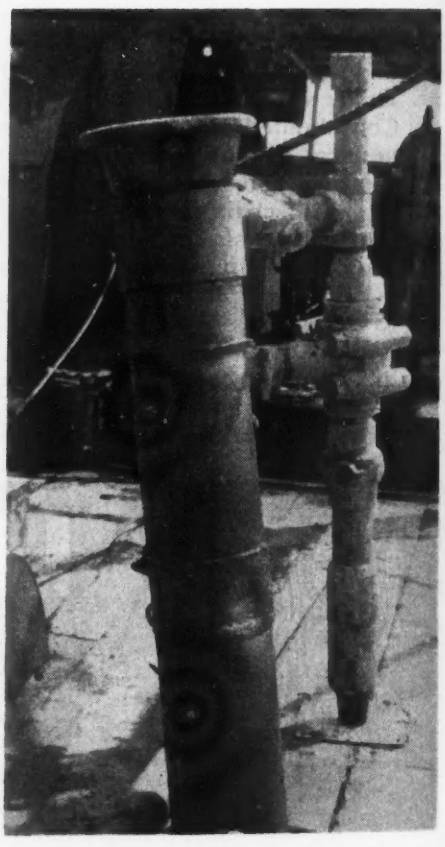
The simplicity and ruggedness of the installation assures long wear with little likelihood of mechanical failure during normal life of the mud tanks.

HOW TO—Give Head Room Under Rotary Hose

When the swivel and kelly are inserted into the rathole prior to pulling the drill string, the rotary hose will block passage over part of the floor if the swivel rests on the drilling floor. In many cases, the loop of hose extending from the swivel to the standpipe is held off the floor three or four feet. If this loop were raised an additional two feet, clearance would be provided for the crew to walk underneath.

Elevation of the rotary hose plus ease of stabbing the kelly in the rathole are made possible by adding a section of ten-inch casing (or whatever size used) to the rathole casing so that the throat of the casing extends three to four feet above the floor. When the swivel is run in the rathole illustrated, it is held higher than normally, and the loop in the rotary hose is elevated off the floor. By raising the swivel four feet off the floor, the loop or sag in the hose is elevated only half that distance, or two feet.

Ease of stabbing the kelly in the rathole is provided by a bell nipple which is added to the rathole by means of a collar. The upper section of the nipple was removed and a ¾-inch solid steel ring was welded in place as shown. This ring takes the rough handling and bumps from the kelly when stabbing the latter in the rathole.



Cameron

FORGED

STAINLESS

STEEL WELL-HEAD FITTINGS

FOR

CORROSIVE

WELL CONDITIONS

According to reliable metallurgists and independent research organizations, stainless steel is the most effective weapon developed to date for combating gas-condensate corrosion. Comprehensive field tests indicate that it is sound economy to invest in this more costly alloy due to its corrosion-resistant quality and consequent long life, in addition to the substantial saving in killing the well and replacing surface fittings.

Cameron's Safety Xmas Trees, long the standard of comparison, are now available fabricated entirely from stainless steel units. Typical of Cameron pioneering in the field of well heads is the forged steel tubing head shown in the assembly at left. To forge a flanged tubing head of this kind from any steel alloy presents complex problems, but to forge one from stainless steel, which requires extremely precise control of metal temperature during the forging operation, is doubly difficult. Forged stainless steel well heads are not available from any other source.

Operators who are concerned with corrosive well conditions are invited to call on the nearest Cameron representative, or write for complete details on Cameron Stainless Steel Xmas Trees.

The above Xmas Tree Assembly is All-Cameron and All-Stainless Steel. It features a Cameron Type "F" Forged Steel Tubing Head, Flow Tee and Type "D" Flow Wing. See your Composite Catalog for complete mechanical details and specifications, or literature will gladly be sent on request.

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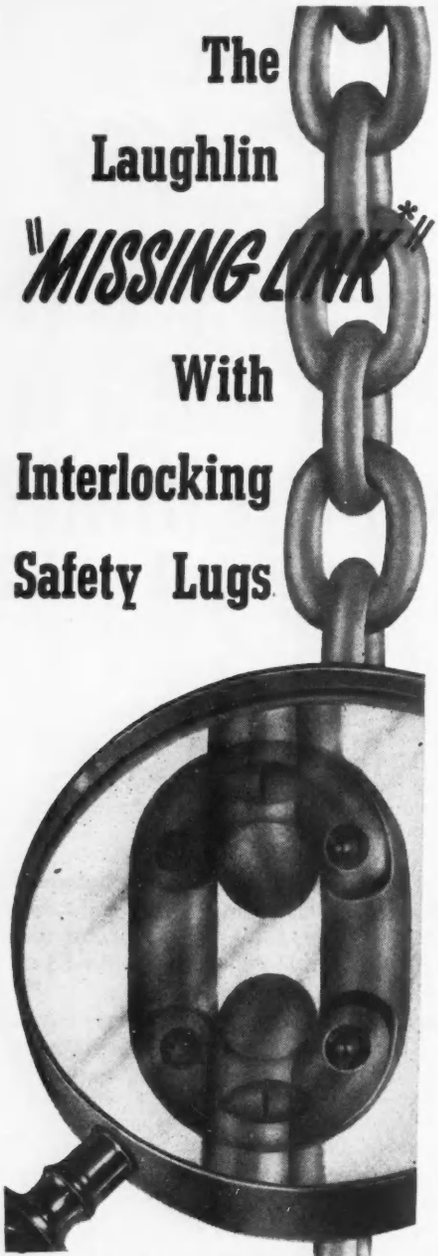

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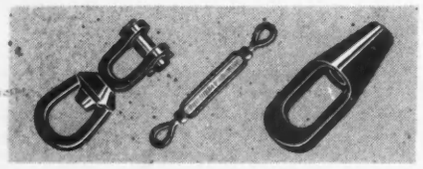
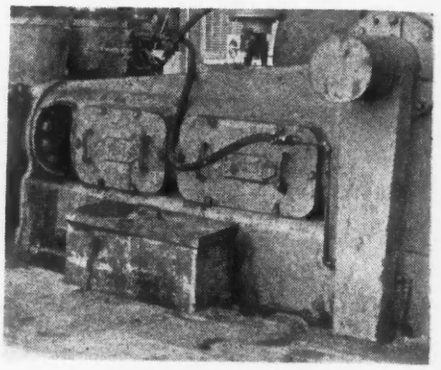


HOW TO—Continuously Lubricate Piston Rods

To preserve the smooth polish of piston rods and prolong the effective life of packing in the glands of the fluid end of mud pumps, one contractor has installed a circulation system so that a continuous stream of oil flows over the rod to lubricate it as well as to keep the polished surface clean and free of abrasives.

A small gear pump is mounted on the bed plate of the mud pump below the crankshaft outer end and connected to this rotating member of the mud pump with a conventional "V" type transmission belt. Overflow oil, that which has poured over the piston rod, drains from the collector basin through piping to a two-compartment oil receiver or surge tank set on the wood mat foundation beside the pump bed plate.

A division plate containing a screen divides the receiver for the oil in two sections so that any heavy material is



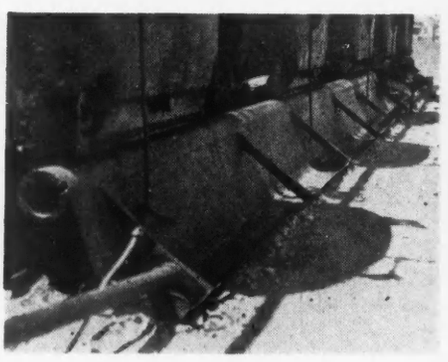
stopped in the first compartment, leaving more or less clean oil flowing to the second compartment from which the small gear oil pump takes suction. Discharge from the circulating pump is through piping and flexible oil-proof hose which delivers the oil to the port in the pump just above the piston rod so that this member is flooded with lubricant as long as the mud pump is in operation.

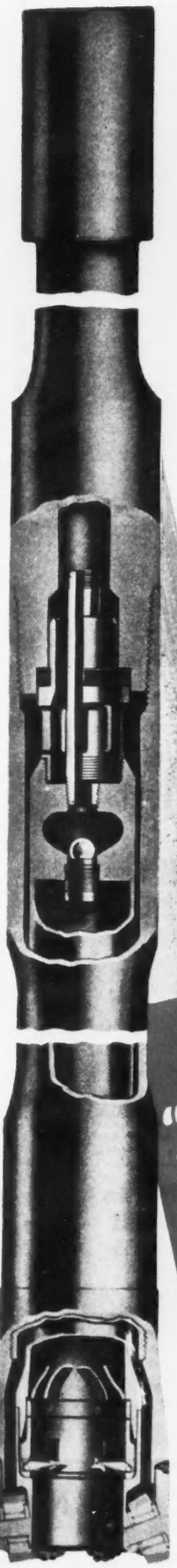
HOW TO—Dispose of Waste Boiler Wash Water

One method used to maintain the appearance of the area at the battery of drilling boilers, and to dispose of waste water, is to combine an apron with the member that supports the boilers at the fire-box end. The top rail of the supporting member, upon which the boilers set, is made of discarded drill pipe, no longer useful for making hole, having legs placed at intervals which may be placed on a wood mat, a concrete floor, or other unyielding substance which will support the weight of the battery without becoming distorted.

The apron is a continuous sheet of tank steel welded throughout the entire contact at the top side where it lays flat against the supporting rail of the boiler pier. It rests against the front legs of the support and is formed at the bottom by making a deeply rolled edge which conducts water and sludge from the manholes or cleanout openings on the boilers.

Included with the apron are several light steel loops, one for each gauge glass drain line, placed at a point which will secure the lower ends of the drain line so they will not be dislocated if struck by a water hose when washing down the front of the unit after a cleanout. The trough may be jetted down by the water connection welded to the end of the support, shown at left.





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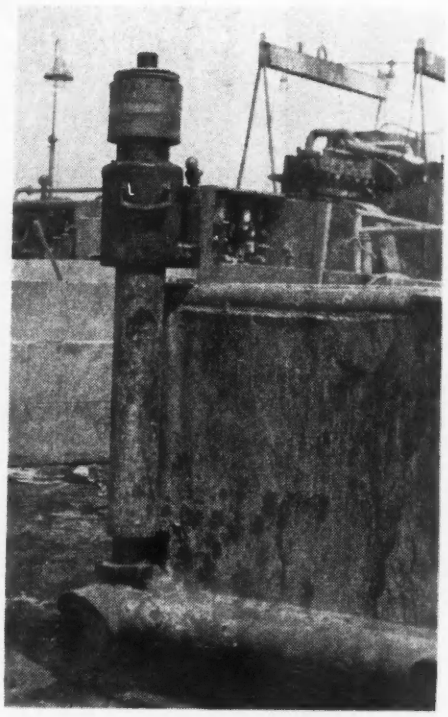
DRILLING HINTS

HOW TO—Remove Mud Pump Piston from Rod

To remove pistons from the tapered end of mud pump rods, one contractor has made use of a hydraulic jack and a piece of pipe. The jack is the type with a hollow riser through which the pump piston rod can be inserted. The pipe nipple is welded to one corner of the large steel tool box where it is most accessible.

The jack is set on top of the upper end of the pipe nipple and the rod passed through until the end of the piston rests on the top of the jack riser when fully depressed. The piston rod adjusting nut is then run on the threaded end until sufficient threads are in the nut to take the strain. The jack is pumped up until the piston is forced from the tapered end.

With this method of removing pistons, hammering with a sledge is eliminated and the piston follower plates are not marred and are in perfect condition for use as soon as new piston packing is replaced. One man can perform this operation in just a few minutes.



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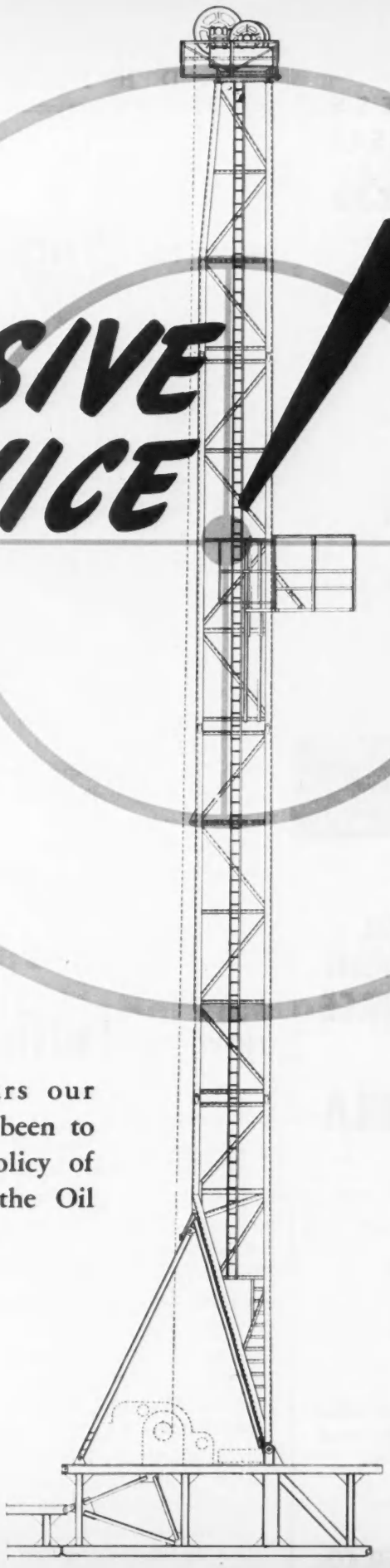

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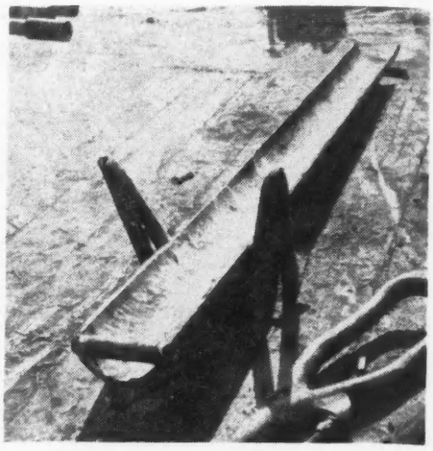
HOW TO—Prevent Fouling Drill Pipe Threads

Laying down a string of drill pipe, including kelly and drill collars, frequently results in injury or fouling of threads or possibly a slight bending of some of the joints. One company, in devising a method of eliminating such injuries and at the same time speeding work, built a special trough equipped with a roller at one end which guides and protects the pin end of each joint as it is lowered from the floor to the walk. A length of casing, cut in half lengthwise as shown in the photograph, was equipped with a small base, the latter being rested upon the edge of the rig floor and spiked or lag-screwed in place. The distant end of the trough rests upon the walkway. As a joint is lowered into the guide, it passes over the roller and slides down, the man on the walk picking up his end with the wagon and running it out on the walk. The device is simple to construct and transport from well to well, and will repay its cost many times over in decreased injury to drill pipe and threads.



HOW TO—Facilitate Repairs to Boiler Flues

Two helpful and practically indispensable tools have been made by the head boilermaker of a drilling contracting company for use when tipping flues of an oil field boiler. The first is a "V" block for lining up the tip with the flue for tack welding. This block is made by using a piece of angle iron, checked for straightness and welded to a two-inch pipe nipple. The tool is laid on a wooden block and retained in the desired position with rig builders spikes driven into the piece of timber. The pipe nipple is held loosely so that it will automatically become self-aligning when the end of the flue is laid in the "V" block for attaching the tip.

After the tip has been tacked at the required number of points to prevent distortion or misalignment, the flue is laid on the second tool so the welder's helper can smoothly roll the flue as the weld is being followed around the joint. This tool is made by attaching two common ball bearings to the web of a short piece of structural steel which is laid on the same piece of timber after the "V" block has been removed. The ball bearings permit easy rotation of the flue while the finish weld is made.

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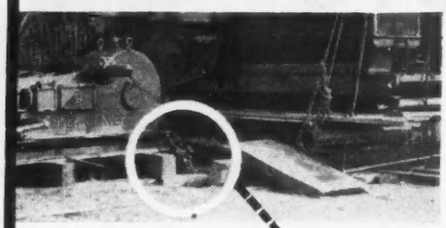

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DRILLING HINTS

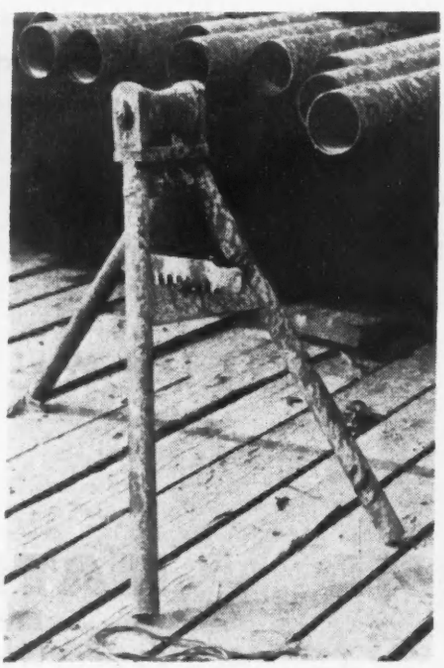
HOW TO—

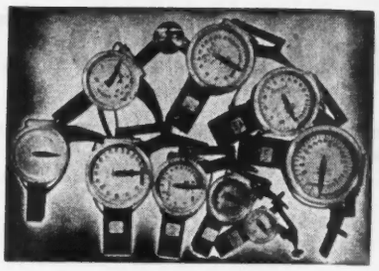
Facilitate Pipe Handling Between Truck and Rack

Handling drill pipe or casing between truck and rack when it is not convenient to back the truck alongside the rack is assisted by an adjustable tripod with a dished roller. Two of the legs are welded to the cross member which carries the roller, and are further braced with a heavy strap steel spacer at a point about three-fifths of the way up.

The third leg is pivoted between the other two, and carries a latch section at a point corresponding to the brace between the other two. The latch is simply a wide piece of tank steel, in the lower edge of which have been cut teeth or notches. By selectively engaging the notches on the brace, it is possible to adjust the distance between the fixed pair of legs and the movable one, so as to change the elevation of the roller to approximate that of the rack or racked pipe to or from which material is to be moved.

The pipe legs are left in their original shape when cut, so as to provide a sharp edge which will dig into the plank runway and thus insure firm footing for the device when handling pipe.





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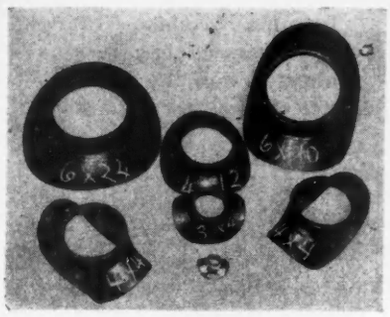

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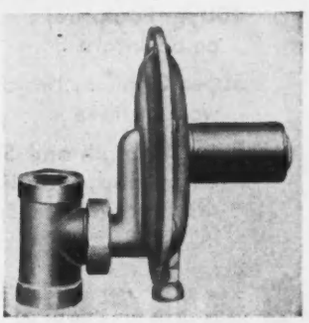

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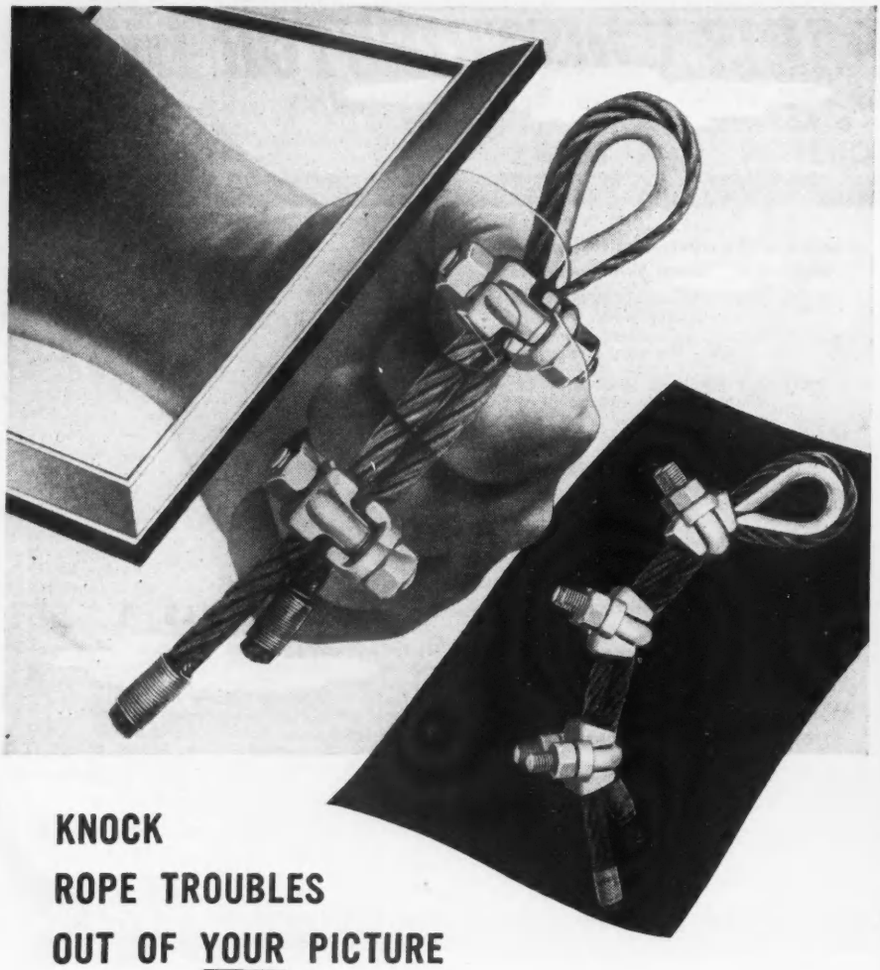

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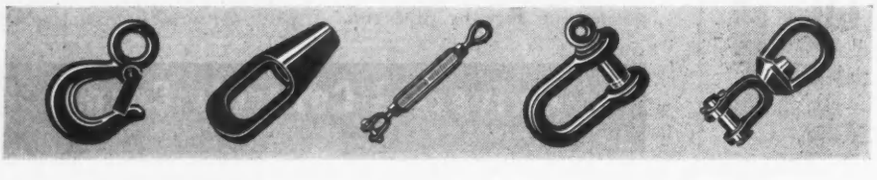
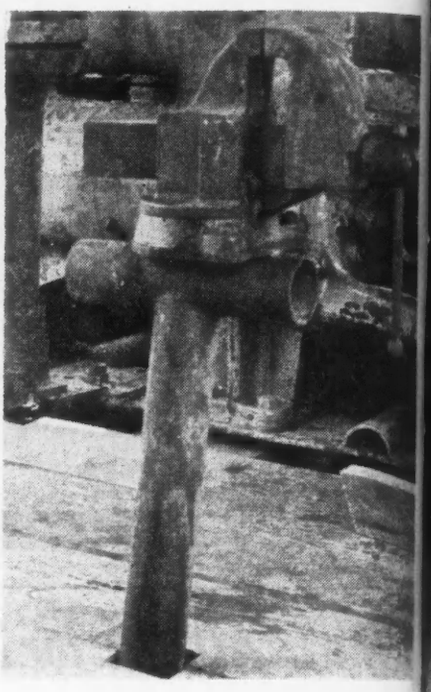


DRILLING HINTS

HOW TO—

Mount Vise Conveniently

Locating a common vise where it is most accessible has been done by a contractor with the aid of a couple of pieces of three-inch pipe and a threaded



collar. The collar is welded to one of the floor beams which support the mud pumps outside the derrick area. The longer piece of pipe, being threaded on one end, is connected to the collar in a vertical position. The shorter piece of pipe is welded as a cross to the top of the riser so that the base of the vise may be bolted down securely. The location is in the area between two batteries of mud pumps so that adequate space is provided for men to use the vise when making repairs.

HOW TO—

Control Drilling Mud With Temporary Surface Pipe

Where long surface strings of pipe must be set, necessitating several days drilling time, the returning drilling fluid which in many cases is a light-weight mud, can be controlled. Rather than allow these muds to flow over the

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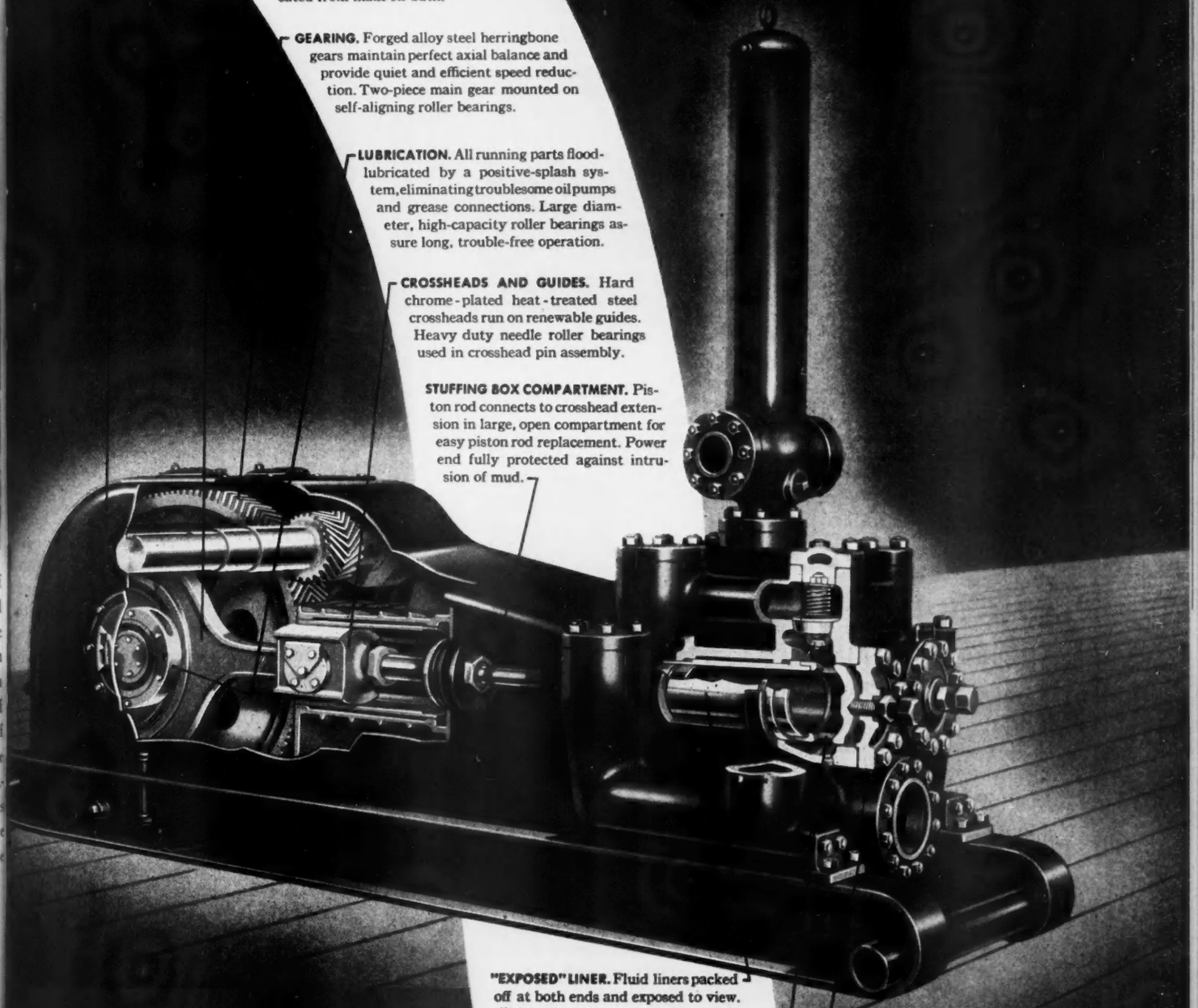

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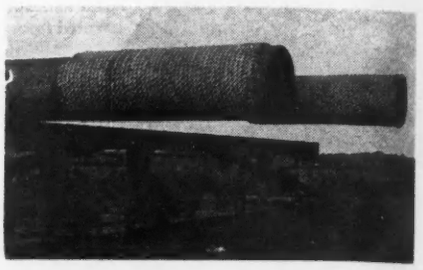
ground around the rig, a temporary surface pipe, approximately 40 feet long, can be used to good advantage.

A shallow hole can first be drilled to accommodate the temporary surface pipe using nothing but water. The pipe, either 20-inch or 16-inch, depending upon the contemplated casing program and thus the hole size, is set in this hole without being cemented. The surface or top of the pipe is equipped with a flange, and the mud return cross bolted in place. In this manner, the light mud used in drilling the permanent surface hole can be salvaged, and the mess around the well and rig eliminated.

To prevent the fluids from returning up the hole behind the temporary surface pipe, a packoff element has been added to the bottom of the joint of pipe. This packing element is in the form of a series of rope coils held in place by nails that have been tack-welded to the pipe and bent over the manila rope. The pipe is wrapped for about six or eight feet from bottom, and when placed in the hole, acts as a packoff for the temporary surface pipe. After the permanent surface string is run in the hole and cemented, this joint of pipe can be removed for use on the next well.

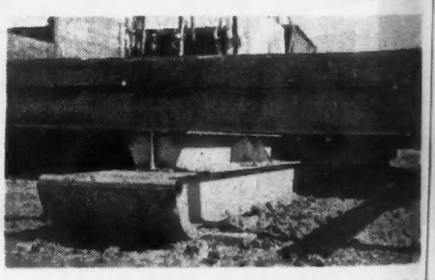


HOW TO—

Build Sled Runners For Rack Skidding

Instead of dismantling the pipe rack each time the rig is skidded to another location, one company, operating in a shoreline area where surface soil is predominently loose sand, fabricated a sled type base which allows the unit to "float" over the top of the sand. A typical skid runner, shown in the accompanying photograph, consists of a pair of I-beams set several feet apart and bridged over, above and below, with steel plate to form a single broad base. The ends were trimmed to allow installation of a rounded front that would cause the base to ride up over slight irregularities of the surface. Atop the sled unit, and running parallel to it, was bolted an H-beam member which in turn supports the transverse rack members, the latter being I-beams on top of which is the planking.

The unit is easily dismantled by removing bolts which tie together, by means of steel ears, the transverse beams and the longitudinal H-beam intermediate member, allowing the rack to be broken down into truck-length components when the rig is moved greater distances.



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Differential Thermal Analysis

by A. J. KAUFFMAN, JR.

THE importance of clays in sediments has been recognized for many years. Only recently, however, have techniques been developed whereby the fine-grained clay minerals can be studied with a certainty comparable to that attained with coarsely crystalline minerals. The excellent work done during the past two decades on clay research has produced much information, but what is probably more important, the work has pointed the way for future investigations. The petroleum industry has acknowledged the increasing importance of clay studies by recommending to the research committee of the American Association of Petroleum Geologists that a comprehensive study of clays be made a major research project.

The fundamental clay minerals have been established and much has been learned about their internal structure. Chemical analyses were formerly the sole method of determining the clay minerals. It has been recognized that calculating a mineral composition from the oxide chemical analysis has many shortcomings. The impurities that were admixed with the clays were not, in many cases, removed prior to analysis and thus the true composition of the clay was obscured.

Present-day techniques include specialized optical (microscopic) methods, X-ray diffraction studies, and dehydration studies by means of the differential thermal method of analysis. It is desirable to verify a clay identification by several different methods rather than base the identification solely upon any one of the methods. Petrographic examination of clay minerals made up of particles as small as several microns is usually difficult. With these small particles a gross optical effect is noted in which the mixture of several constituents gives the appearance of a single constituent with the mean optical characteristics of the mixture. X-ray examination is often an unsatisfactory means of identifying the clay minerals because of their occurrence, in many cases, as mineral mixtures. The X-ray pattern of the major constituent usually predominates and the clay mineral may not be detected. A relatively small percentage of quartz will yield a pattern so intense that it may mask larger amounts of clay.

It is the purpose of this paper to discuss the identification of clay minerals by the method of differential thermal analysis.

Essentials of the Method

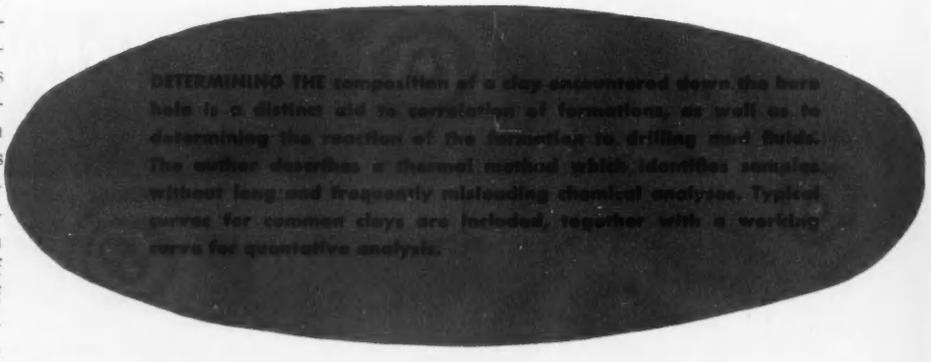
The differential thermal method of analysis is based upon the suggestions of Le Chatelier[1] made in 1887 and more fully developed by succeeding scientists such as Wohlen in 1913,[2] Orcel in 1927,[3] Orcel and Caillere in 1933,[4] Granger in 1934,[5] Insley and Ewell in 1935,[6] Jourdain in 1937,[7] Norton in 1939,[8] Hendricks and Alexander in 1939,[9] and Grim in 1942.[10]

The differential thermal method of analysis detects and records any thermal effects that occur in a hydrous mineral when it is heated. These effects may be the loss of water, decomposition, oxidation, crystallization, and/or change of crystal lattice. The magnitude of the thermal effect as well as the temperature at which it occurs is recorded. The determination is carried out by heating a clay sample and a thermally inert substance (alundum, calcined alumina) in a suitable holder, and noting any temperature difference between the two by means of a difference thermocouple.

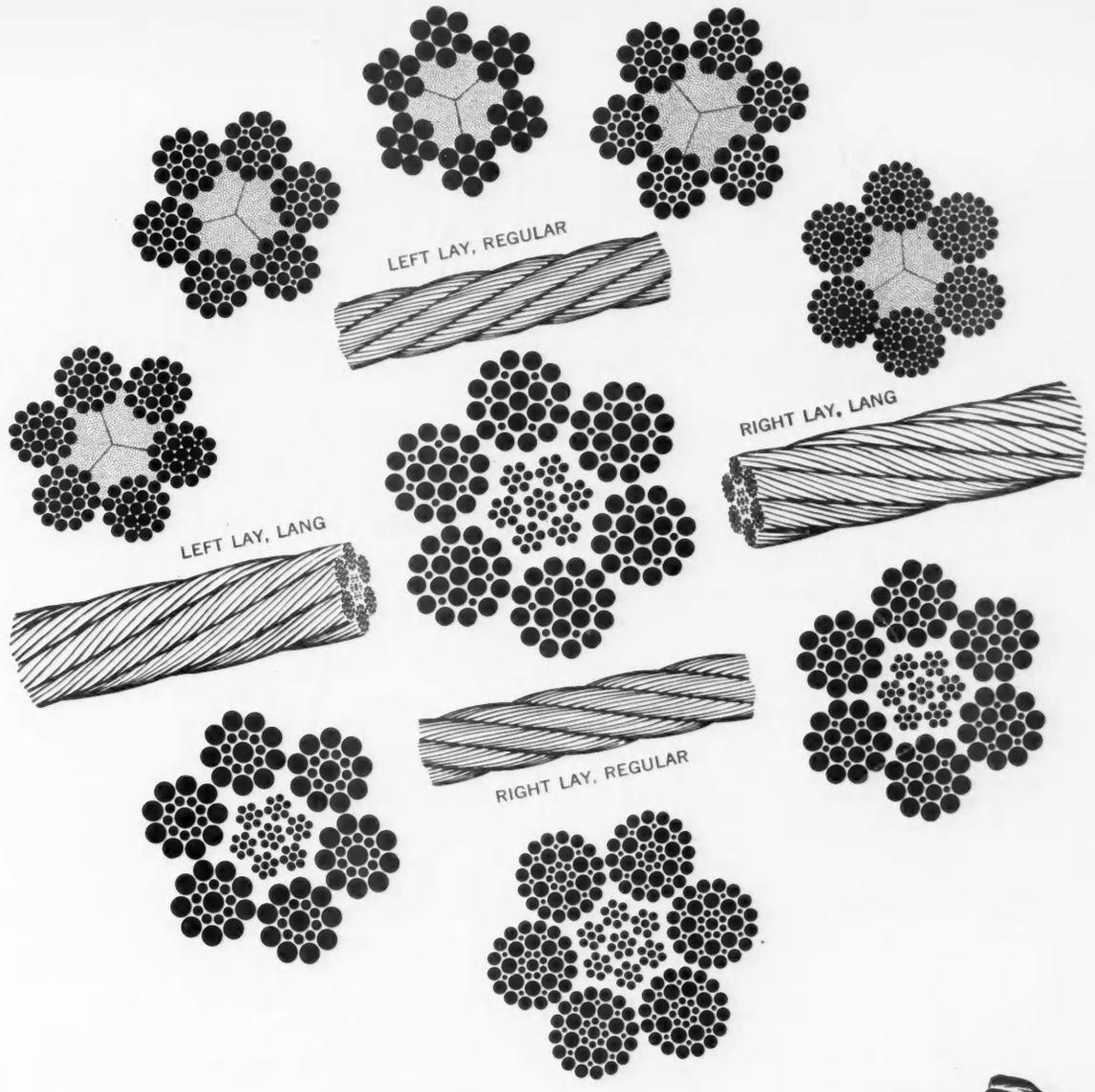
A thermal curve is a dynamic record of thermal reactions occurring within the samples being studied. In determining water loss versus temperature for a hydrous material it is seen that the reaction is not instantaneous. According to Speil[11] on the differential thermal curve this dehydration and/or recomposition extends over a longer temperature range because the temperature of the sample continues to rise during the reaction. During the heating two thermal effects must be considered, the heat of the thermal reaction and the differential heat inflow from the nickel block to the sample. When the temperature difference between the two thermocouples is zero the heat input into each cavity must be the same. Then when the sample is absorbing heat at a rate greater than the reference there will be a downward deflection of the thermal curve. The opposite effect will result in an upward deflection of the curve. In describing differential thermal curves any deflection is called a peak. If it is a downward deflection the peak is known as endothermic, and if the deflection is upward the peak is called exothermic.

The intensity of the thermal reactions and the temperatures at which they take place are different for each clay mineral, and therefore provide a means of identification. They are different because each of the clay minerals contains different amounts of water which is driven off at different temperatures, and because all of the clay minerals do not undergo the same lattice changes on heating.

Until recently, most investigators have used the apparatus designed by Norton[8]



DETERMINING THE composition of a clay encountered down the bore hole is a distinct aid to correlation of formations, as well as to determining the reaction of the formation to drilling mud fluids. The author describes a thermal method which identifies samples without long and frequently misleading chemical analyses. Typical curves for common clays are included, together with a working curve for quantative analysis.



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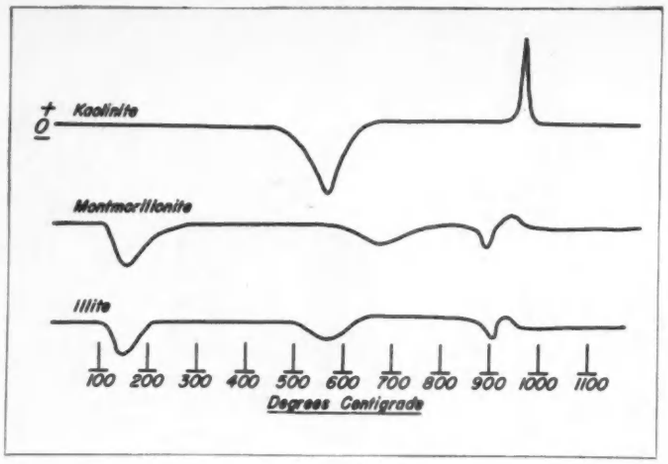

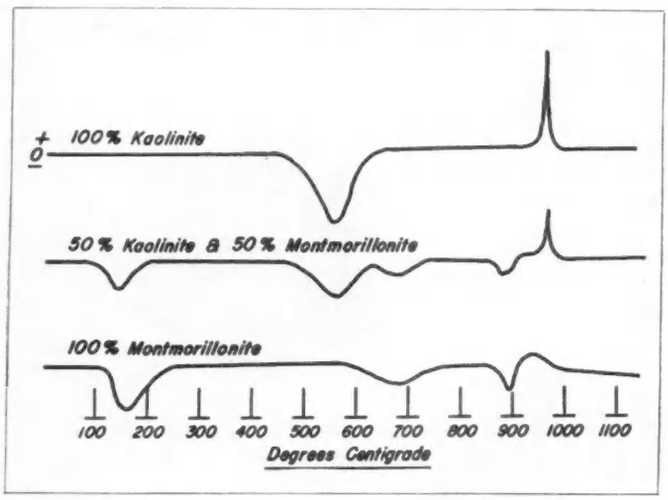

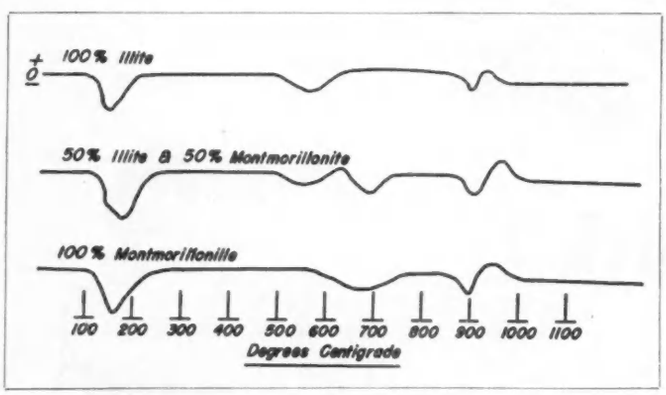

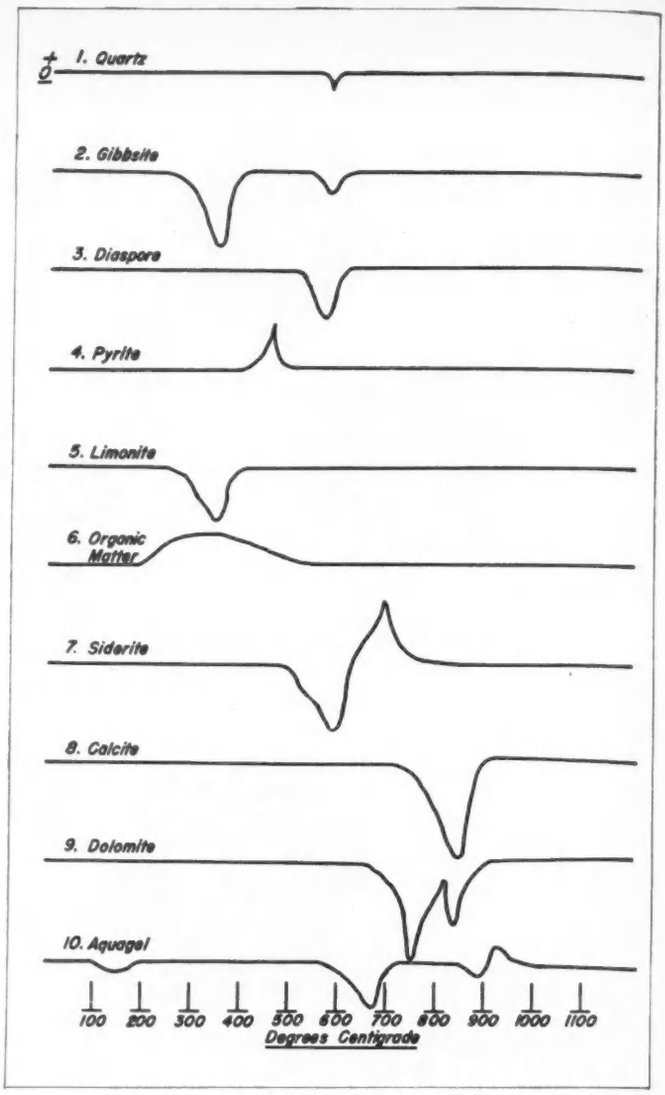

FIGURE 1 (top left). **Differential thermal curves of kaolinite, montmorillonite, and illite.**

FIGURE 2 (right). **Differential thermal curves of minerals usually associated with clays.**

FIGURE 3 (center left). **Mixture of kaolinite and montmorillonite.**

FIGURE 4 (lower left). **Mixture of illite and montmorillonite.**

and modified by Hendricks and his colleagues.[9] The main features are a nickel specimen holder; an electric furnace; a suitable mechanism for controlling the heating rate of the furnace; the necessary thermocouples and a camera-galvanometer recording system.

Specimen holder: The specimen holder is usually a nickel block made by milling flat the top and bottom of a piece of one-inch round stock. The dimensions are usually 1x1x5/8-inch thick. Two laterally positioned holes one quarter-inch in diameter and three eighths-inch deep are provided for the sample and the reference material. The block is mounted on an alundum cylinder that fits inside the furnace tube. Grim[10] uses a four hole block, one for the sample and the other three for the reference material. The extra holes are used for thermocouples to more accurately regulate the temperature. Investigators at The Carter Oil Company Research Laboratory use a four-hole block, one for the reference and the other three for samples. Kerr[12] uses a nine-hole block, six of the holes for samples and three for reference holes.

Furnace: The furnace generally used is an electrical resistance tube type having the following general dimensions: 12 to 18 inches long and eight to ten inches in diameter. The body is a steel shell with transite ends. The middle portion of a 2 1/8-inch alundum tube is wound with either nichrome or kanthal wire. Cast, powdered or brick type insulating material can be used. This type of furnace is designed to go to 1200° C. and will draw about ten amperes.

Heating Rate Control

The heating rate (usually 10-12° C. per minute) is controlled by two variacs. One is preset at approximately 50 percent transmission and the other motor driven from 0-100 percent transmission. A Bodine constant speed motor, 1620 revolutions per minute with 1120-1 reduction coupled with a 150-1 reduction gear, is used by Hendricks.[9] Different combinations of motors and gears can be used to obtain the desired rate. Kerr[12] uses a recorder as part of a program controller. This type of program con-

HOWCO REPORTS TO ITS CUSTOMERS . . . NO. 6 OF A SERIES

The Test of Any Policy Lies in the Results

Let's Take a Look at the Results of the Oil Industry's Cementing Policy

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Service: Uniform cementing service to all operators regardless of location is and always has been a cardinal Howco policy. In its fulfillment we have never hesitated to extend operations and expand personnel and equipment. Example: In 1927 Halliburton operated 52 outfits out of 24 camps in three states. In 1947 it operated 361 outfits out of 170 camps in 20 states. Industry-wide acceptance makes possible industry-wide planning, placement and routing to take care of emergency as well as normal demands.

Prices: Compare today's drilling costs with those of a quarter-century ago and you will note drastic increases in all cost factors but one: Despite inflationary trends, despite tremendously increased costs, the average revenue per well is lower today than in 1924. For the explanation of that phenomenon look to efficient, large-scale operations made possible by industry-wide endorsement.

Yes, the test of any policy lies in results —and the results of Halliburton's relations to the industry speak for themselves.

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OIL WELL CEMENTING COMPANY

DUNCAN, OKLAHOMA

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troller probably will replace the motor-driven variac in future developments of the apparatus.

Thermocouples: Platinum-Platinum 10 percent Rhodium or Chromel-Alumel couples can be used. The Platinum-Platinum 10 percent Rhodium couple produces an electro motive force of ten microvolts per degree centigrade and the Chromel-Alumel couple produces an EMF of 40 microvolts per degree centigrade. The platinum couples have lower sensitivity but have longer life and greater sustained accuracy when used repeatedly at temperatures as high as 1200° C. They also have a lower limit of departure over this temperature range.

The maximum average deviation from furnace temperatures due to an endothermic reaction is 8-10° C. This will produce an EMF of 80-100 microvolts from the Platinum-Platinum 10 percent Rhodium couple.

Recording System: The differential and furnace temperatures were originally (since Norton's paper[8]) recorded photographically by means of reflecting galvanometers and a suitable camera. Hendricks and his colleagues[9] fastened bromide paper on a revolving drum arranged in a light-tight housing. A vertical slit of light from a lamp arranged at a distance of one meter is focused upon the mirror of a reflecting galvanometer. The reflection of this slit of light intersects a horizontal slit opening on the recorder housing and traces a continuous line on the bromide paper. The difference galvanometer traces a continuous line representing the differential temperature and the furnace temperature galvanometer traces a continuous diagonal line across the record. Norton,[8] Berkelhamer[13] and Speil[11] use a signal light that flashes automatically at 50-degree intervals instead of the continuous furnace temperature record. Berkelhamer[13] uses a roll of photostat paper instead of the bromide paper.

A camera-galvanometer recording system must either be used in a semi-darkened room or placed in a light-tight housing. These two undesirable factors coupled with the desire to make simultaneous multiple records led to the use of a recording potentiometer in place of the camera-galvanometer system. The potentiometer system provides greater accuracy because it draws negligible current during balance, eliminates any errors due to ordinary changes in the resistance of the thermocouples or leads, and is not dependent upon magnets or springs and affords improved recording. Standard potentiometers as offered by the manufacturers will probably have to be modified to meet the special requirements of this particular type of recording.

The apparatus used in this method of analysis is not available, as such, from any laboratory supply house. Specifications of the apparatus, however, appear throughout the literature. Norton[8] furnishes a complete sketch of the furnace designed by him and used, with modifications, by most of the other investigators. Hendricks[9] supplies details of the sample block, a photograph and the general scheme of the camera arrangement. Berkelhamer[13] gives the specifications for the complete apparatus. Speil[11] offers a wiring diagram. No detailed paper has been published to date describing the use of the recording potentiometer.

During the last two decades clay research has progressed steadily. New and important concepts of lattice structure and ionic substitution have been clarified. General advancement in colloid chemistry and in problems of base exchange have added to our knowledge of the clay minerals.

Clays, according to Grim,[10] are aggregates of extremely minute particles of one or more species of a small group of minerals, known as the clay minerals. Three groups of these clay minerals are recognized: kaolin, montmorillonite and illite. The clay particles are crystalline, have excellent cleavage, and range between two and five microns (0.002-0.005 mm) in size.

Brief descriptions of these groups follow:

Kaolin group: Kaolinite is the most common member of this group. Also included are dickite, nacrite, halloysite and allophane. They are complex silicates with the general formula $(OH)_8Al_4Si_4O_{10}$. The kaolin group is the most stable of the clay minerals. There is no tendency for aluminum to be replaced by iron or magnesium because the valency requirements have been satisfied and the structure is balanced. Kaolinite was thought at first to be the most important constituent of all clays. Latest evidence by Grim[10] and others show kaolinite to be completely wanting in some clays. Kaolinite is the main constituent of residual and sedimentary kaolins.

Montmorillonite group: This group of clay minerals consists of the most common member, montmorillonite, plus beidellite, nontronite, and saponite. The group has the general formula $(OH)_4Al_4Si_8O_{20}nH_2O$. This group is similar to the kaolin group in that they are alumino-silicates but the Al:Si ratio is lower. Montmorillonite is thought to have a three layer lattice structure. It is this lattice arrangement that accounts for the loosely held water. It is so loosely held that the mineral may be shown to vary perceptibly in water content with change in the humidity of the atmosphere. Unlike stable kaolinite there is a tendency for ions having low valence to replace both the aluminum and silicon thus leaving unbalanced charges that are neutralized by sodium, calcium or magnesium. This explains the base exchange properties of the group. Montmorillonite is the main clay constituent of bentonites and it has been demonstrated that bentonites play an important role in many of the more productive oil regions.

Illite group: Illite or "hydromica" has been recognized for some time as a mica-like material formed during the alteration of feldspathic materials to kaolin. It differs structurally as well as optically and chemically from mica. A more recent concept is that this group is formed as an intermediate alteration product produced in clay or shale of sedimentary origin. The group has the general formula $(OH)_4K_y(Al_4Fe_4Mg_4Mg_6)(Si_{8-y}Al_y)O_{20}$. It has a three-layer lattice structure and its replacement behavior varies, sometimes undergoing base exchange like the montmorillonites and then again being stable like the kaolin group. Grim[10]

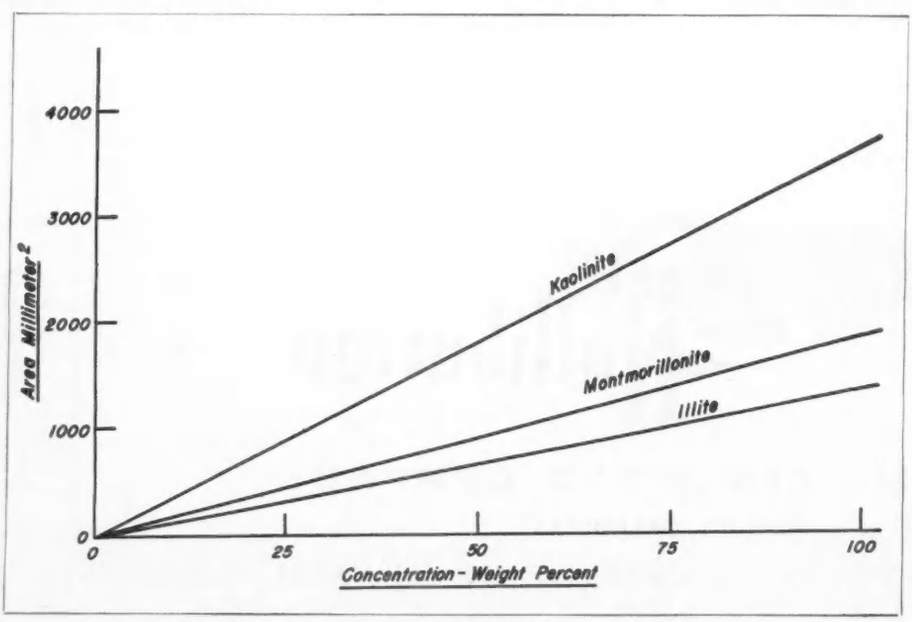

FIGURE 5. Working curve for quantitative estimations

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believes that it is the most widely distributed clay mineral in present day marine argillaceous sediments.

A better understanding of the clay minerals is essential before many of the problems confronting the petroleum industry can be satisfactorily answered. Clay is involved in almost every problem confronting the petroleum technologist. It is the major constituent of shales and therefore of prime importance in the consideration of any of the many problems involving shales. Clay in varying amounts is usually found in oil sands and thus may affect their permeability, porosity and connate water content. Drilling mud is another important item that involves clay and gives rise to such problems as base exchange and the effect of additives upon clay. It is also thought that clay plays an important part in electric logging. It has been suggested that the self-potential curve is a measure of the electrical charge on the clay and is related to the ionization of the base-saturated clay mineral.[14]

It may be restated at this point that the purpose of this paper is to call attention to a relatively new analytical tool that can and probably will play an important part in any of these problems by first aiding in the identification of the clay mineral involved.

Differential Thermal Curves

Most reactions that occur during thermal analysis determinations are not instantaneous and therefore are spread over varying temperature ranges. These ranges with their peaks are characteristic for specific minerals and can be reproduced if the conditions remain unchanged.

The preparation of the sample is important in order to obtain reproducible results. Samples are usually ground to pass a 65-mesh screen and then placed in a drying oven at 90-100° C. for at least an hour. Grim[10] and others place the sample in a constant humidity desiccator after removing from the oven. Care must be taken always to pack the samples into the cavities in the same manner and to be certain the thermocouple is centered in the mass. It is usually advisable to weigh the sample used. Grain size and rate of heating will affect the thermal curve and will be discussed later.

Kaolinite: The differential thermal curve for kaolinite has been worked out in detail. The thermal effects that take place during each of the reactions have been identified.

As we already know from dehydration curves of kaolinite the mineral does not lose its water instantaneously but rather over a specific temperature range. In considering the curve there is no thermal effect noted from room temperature until the beginning of the endothermic reaction that has its peak at about 580° C. This means that there is no potential difference between the thermocouple in the kaolinite and the thermocouple in the reference material. At approximately 450° C. the kaolinite starts to lose its water and since this is the type of reaction that requires heat to drive it to completion, the actual temperature of the sample becomes less than that of the reference, and the magnitude of the resulting potential difference is recorded on the differential thermal curve. Again from the dehydration curve data, it is indicated that this thermal reaction is completed at some temperature on the return limb of the curve. For convenience it is assumed to be complete at the point that the differential thermal curve indicates no potential difference.

This endothermic peak of the kaolinite curve indicates loss of water and destruction of the crystal lattice. The resulting mass, according to Insley,[6] is a mixture of amorphous alumina and amorphous silica. After this endothermic reaction there is again no potential difference until a sharp exothermic reaction with a peak at about 980° C. This reaction represents the crystallization of the amorphous alumina. Since this type of reaction is accompanied by an evolution of heat, the temperature of the sample becomes higher than that of the reference material and the resulting potential difference is recorded as an exothermic peak. Insley[6] believes that the silica has a restraining effect upon the alumina preventing its crystallization until it has absorbed sufficient energy to break loose from the bond. X-ray examination indicates that this reaction is the formation of gamma alumina.

The endothermic peak at about 580° C. and the exothermic peak at about 980° C. are characteristic for kaolinite and will be detectable in mineral mixtures when the kaolinite concentration is as low as 10 percent. Other members of the kaolin group of clay minerals have somewhat similar thermal curves. The exothermic peak occurs at the same temperature for all of them while the temperature of the endothermic peak varies enough to permit identification. Hydrated halloysite has in addition an endothermic peak at about 150° C. due to loosely held water.

Montmorillonite and illite have three layer crystal lattices and so we expect them to yield differential thermal curves different from the two layer lattice kaolins.

Montmorillonite: The initial low temperature endothermic peak (100-250° C.) of montmorillonite is due to the loss of the "swelling water" loosely held between the basal planes. An endothermic peak of greater magnitude (600-700° C.) represents the loss of constitutional water. The lattice structure is not affected during either of these two endothermic reactions. A third endothermic peak at about 900° C. (not always well developed) represents the destruction of the clay lattice. Immediately following this peak is a small exothermic peak thought to be associated with the formation of spinel. We will presently see that the differential thermal curve for illite is somewhat similar. However, the initial endothermic peak of montmorillonite is usually of greater magnitude and extends over a wider temperature range. The major endothermic peak for montmorillonite occurs approximately 100° C. higher than the corresponding illite peak.

Illite: The differential thermal curve representative of illite has a low initial endothermic peak (100-200° C.), a second endothermic peak between 500-600° C. and a third endothermic peak at 900° C., followed imemdiately by an exothermic peak of about the same magnitude. The same interpretation is given to the final endothermic-exothermic combination for illite as for montmorillonite:

About the Author

A. J. KAUFFMAN JR. was born in Irvington, New Jersey, in 1912. He received his Bachelor of Science degree in chemistry from Seton Hall College in 1935. From June of that year until October, 1939, he worked as an analytical chemist at the Esso Laboratories of the Standard Oil Development Company, Bayway, New Jersey. After leaving this position he entered Columbia University for graduate work in mineralogy and economic geology and received his M.A. degree in 1941. In the same year he joined the U. S. Bureau of Mines as a chemist-petrographer and was stationed at the Eastern Experiment Station, College Park, Maryland. He is now at the Bureau's Northwest Electrodevelopment Laboratory, Albany, Oregon.

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destruction of the crystal lattice and formation of a spinel. In cases where montmorillonite and illite occur as mixtures, the second endothermic peak serves to distinguish them.

It was previously stated that both rate of heating and particle size affected the thermal peaks. They will be treated briefly at this point.

Heating rate: Changes in the rate of heating will affect the position of the peak and to some extent its shape. According to Speil,[11] the slower the heating rate the lower and broader the peak when plotted on the differential thermal record because the differential heat inflow into the specimen tends to keep the temperature differential low. The apex of the peak and the return to zero occur at a lower actual temperature with slow heating. Since the return to the zero line is a time function as well as a temperature difference function, the return to the zero line will occur at a higher actual temperature with more rapid heating. For comparison of peak positions with those found in the literature, rates of 10-12° C. per minute are preferred.

Particle size: A decrease in the particle size increases the area of the surface and therefore there is an increase of absorbed water. In the finest fraction this absorbed water results in an endothermic reaction of varying magnitude with a peak at about 150° C. In general the sharpness of the endothermic peak increases with decrease in particle size indicating that the smaller grains probably dehydrate more uniformly. The smaller the particle the lower the temperature of the resulting peak. Speil[11] offers interesting data on this point.

The differential thermal curves of minerals usually associated with clays are found in Figure 2.

1. Quartz—yields a small but sharp endothermic peak at about 578° C. due to the change of the crystal lattice from the alpha to beta modification. This peak serves as a good reference temperature when standardizing the apparatus.

2. Gibbsite—yields a strong endothermic peak at about 350° C. and a smaller endothermic peak at about 575° C. The initial peak represents the loss of $2H_2O$ to form boehmite and the second peak is the loss of the remaining water and destruction of the boehmite structure.

3. Diaspore — yields a strong endothermic peak between 575-600° C. Note: Diaspore is distinguished from kaolinite by the lack of the exothermic peak at 980° C.

4. Pyrite and marcasite—yield an exothermic peak at 450° C.

5. Limonite—yields an endothermic peak at about 350° C.

6. Organic matter — yields a broad exothermic peak over the range 200-600° C.

7. Siderite — yields an endothermic peak at about 600° C. and an exothermic peak at 700-725° C. The endothermic peak is the decomposition of the carbonate and the exothermic peak results from the oxidation of the iron from the ferrous to ferric state.

8. Calcite—yields a strong endothermic peak at about 850° C. due to decomposition of the carbonate.

9. Dolomite—yields a double endothermic at 750 and 850° C.

10. Aquagel—this curve represents a commercial drilling mud. The magnitude and position of the peaks indicate that montmorillonite is the main clay constituent of this material.

Quantitative Application

The data yielded by the differential thermal method of analysis can be quantitative as well as qualitative. The magnitude of any particular peak is a measure of the amount of the constituent involved in the reaction causing the peak.

The curves representing synthetic mixtures of kaolinite and montmorillonite and illite and montmorillonite appear in Figures 3 and 4, respectively. Only the even weighted mixtures are given but they serve to illustrate the point. The curves also indicate the relative ease in distinguishing and identifying constituents of mineral mixtures.

It has been shown by Norton[8] and Speil[11] that the area of the peak involved affords the best quantitative measure. The area of the peak is measured by means of a planimeter or other suitable device and the values obtained compared with a table of standard values or read directly from a curve. A working curve can be constructed by plotting area of the peak in square millimeters against concentration of a pure clay standard. Since the curve is essentially a straight line several concentrations will afford enough points to adequately delimit it. Figure 5 represents the working curves of the constituents used in the mixtures illustrated in Figures 3 and 4.

Norton[8] suggested the quantitative method. Grim[10] reports data on mixtures of kaolinite and illite and montmorillonite and illite. Berkelhamer[13] devotes an entire paper to the quantitative determination of quartz. Speil[11] offers data for mixtures of kaolinite and quartz, kaolinite and diaspore, kaolinite and montmorillonite, and also for bauxite flotation products.

ACKNOWLEDGEMENTS

This paper has been written to call attention of the petroleum industry to a recently developed analytical tool that is assured of an important position in clay research of the future. The author has used many of his unpublished notes on differential thermal analysis and has also drawn freely upon the entire literature of the subject. The contributors of major papers have been acknowledged in the text and others listed in the bibliography.

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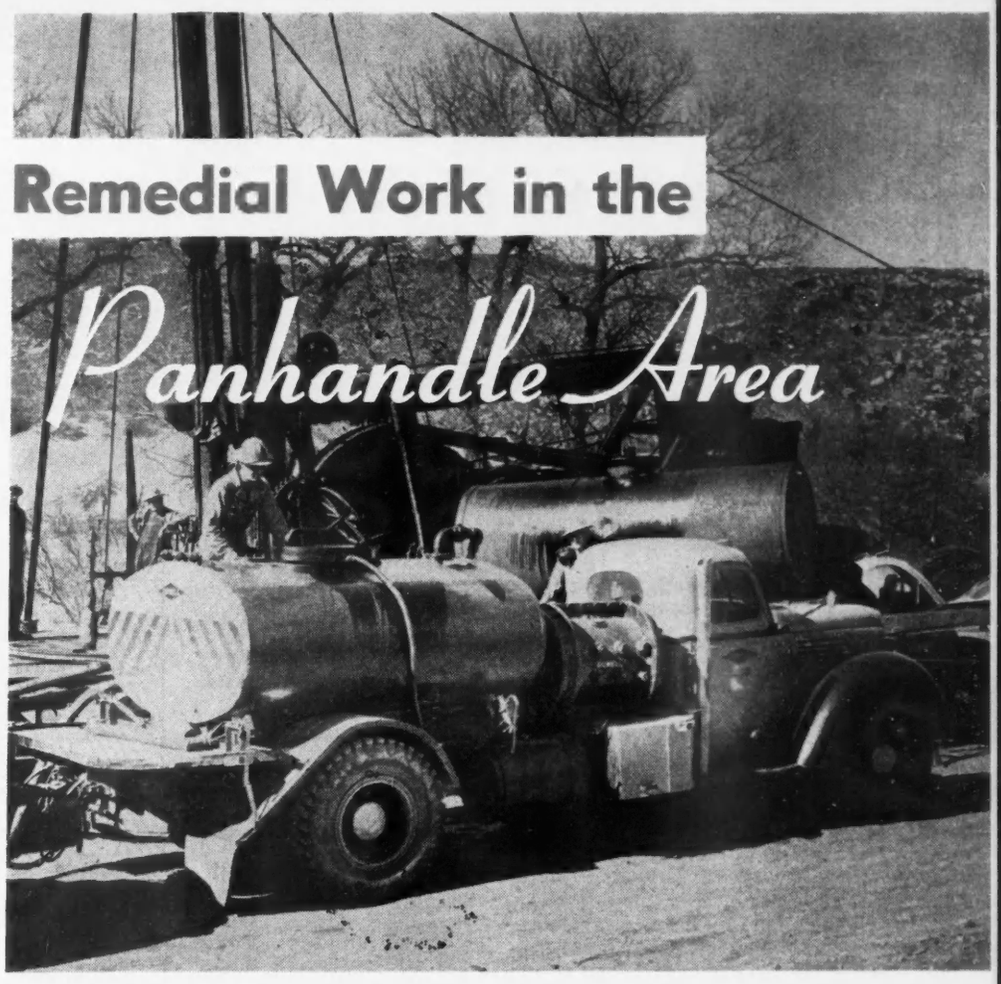
Cleanout and Remedial Work in the Panhandle Area



Well being treated with 15 percent acid. The open hole method was used and the acid displaced with oil.

THE AUTHOR discusses various methods for increasing production from wells in the area, evaluating each and indicating limitations. The discussion stresses the value of complete well records, the author recommending thorough study before application of any of the methods he describes.

By E. V. GARRETT
J. M. Huber Corporation

THE producing life and maximum recovery of oil from a pumping well in the Panhandle will be greatly reduced due to one or more of the following reasons: (1) the accumulation of paraffin; (2) caving formation; (3) inorganic precipitates such as gypsum and calcium salt; (4) leaking or collapsed casing; (5) water intrusion. Any of these conditions can be remedied by various workover methods.

The well record, samples, and the production history of the well should be thoroughly studied before any work is attempted.

From these records the operator determines type of producing formation; present and past production; benefits to be gained by reconditioning; and present and past lifting cost. These and the price of oil will influence the operator's decision as to whether or not it would be economical to recondition the well.

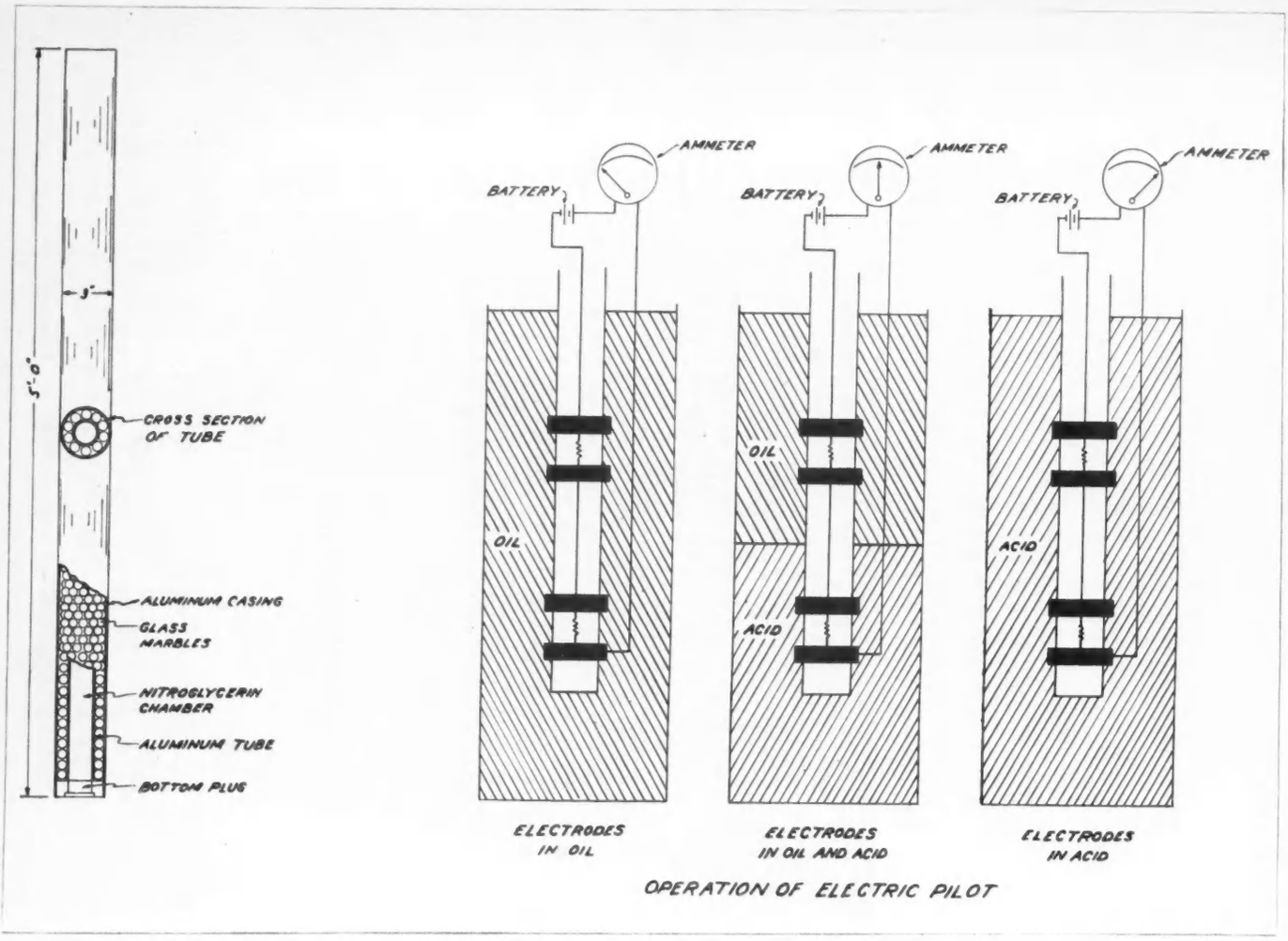
There are three types of producing formations in the Panhandle; limestone, dolomite, and granite-wash. The granite-wash is either cemented with dolomite, limestone, or mixed with shales. Each type of pay offers a different problem for any workover job.

Paraffin accumulation in perforations and on the sand face is probably the most field-wide reason for decline in productivity. If the oil producing casing has been set through the producing formation, the paraffin accumulation in the pipe and to a large extent that which has formed within the perforations can be removed by swabbing. Reduction of the pressure created by the swab within the casing will allow an increased flow of the oil from the formation, thereby enlarging the openings in the perforations. As the swab is pulled to the surface it will remove any formation of paraffin from the wells. Repeated swabbing efforts will result in considerable increase in production. This is usually followed by the introduction of hydrochloric acid by one of several methods and in concentrations of 3 to 15 percent. The use of hot distillate is the common practice employed in granite-wash areas of the Panhandle.

If there is open hole below the casing, the paraffin is removed by scraping the

About the Author

E. V. GARRETT started his career in the oil fields as a roustabout for Gulf Oil Corporation 12 years ago. He says he took to the work "like a duck takes to water" and everything connected with oil field work not only interested him tremendously, but also provided an education "which I could not get out of books." Garrett has worked for only two companies, Gulf Oil and J. M. Huber Corporation, joining the latter in 1939. One other boss he has had—Uncle Sam—but that tour of duty was devoted mostly to "mopping up" operations.



OPERATION OF ELECTRIC PILOT

formation with any of the patented tools designed for this purpose. The swab is employed to remove the paraffin from the pipe. After the hole has been cleaned, acid, explosives, or hot distillate are used. The one to be used is determined from past experience.

In Gray County there is a considerable amount of granite-wash production. The paraffin problem there is met by using hot distillates. This seems to be the common practice but some operators prefer the use of paraffin solvents.

If a liner has been installed in a well another problem is presented. The swab is employed to clean up the casing. If it is possible to remove the liner it is pulled to the surface and the perforations are cleaned. If is is in good repair it is replaced as soon as the hole has been reconditioned.

At times it is impossible or impractical to remove the liner. If such is the case one of the following methods of paraffin removal is employed: (1) introduction of acid; (2) placing hot distillates or paraffin solvents in the liner; (3) gun-perforating. When hot distillates are used they should be promptly removed to prevent the waxy material from again solidifying in the well as it cools. Steam, calcium carbide, and mixtures of caustic soda have been used in the Panhandle with limited success.

Caving Shale Problem

After the production casing is set, beds of caving shales are frequently encountered. A liner is then run in the open hole to prevent these cavings from filling the bore of the hole; however, as the producing life of the well is extended, this caving action continues until eventually these cavings plug the liner and production from the well is seriously impaired if not completely cut off.

Solving this problem is accomplished by removing the liner and cleaning the perforations. If it is impossible to remove the liner the use of acid or pressure-washing with oil has proven successful in most instances. Gun perforating or marble shooting often produces the desired results.

If the caving condition becomes troublesome while cleaning out, the tools are churned in the hole to cause further caving and then the hole is cleaned out in preparation to sealing the cavity formed. Plastic is also used. After the material used has set for sufficient time the hole is redrilled and tested and if the procedure is successful, the liner is again run. If a liner was not in the well at the time of the workover, one is installed.

Gravel packing has been used to combat caving conditions. Extreme caution is used in the selection of the gravel. The gravel is washed-pea gravel of the size that will pass one-quarter inch opening but not one-eighth inch. It is placed in the well by bailer.

In certain areas of the Panhandle inorganic precipitates are formed by the chemical action of underground waters. Encountered most frequently are insoluble calcium sulfates. The chemical action is aggravated by the chilling effects produced by the expansion of gas and pressure reduction within the pump and tubing. One particular well in the Bryan pool requires pulling the tubing and cleaning its perforations as well as the gas anchor once every three or four months.

The best method for reconditioning wells where this condition exists is in preventive methods, as calcium sulfate (gypsum) is not readily soluble in either water or acid. The introduction of fresh water into the well has been used with limited success but is not practical. Reducing to a minimum the agitation in the bottom of the hole has prolonged production before the perforations become

plugged. If these methods fail, the equipment must be pulled and cleaned.

The action of electrolysis and corrosion causes many leaks in the Panhandle area. This allows water behind the pipe to enter the well and unless imediate remedial measures are taken, serious consequences will occur. If a casing leak in a gas well occurs, large volumes are lost to the atmosphere. Surface waters are also contaminated in this manner.

The first concern is to determine the depth at which the pipe is leaking. Several methods are used to determine the depth. Bridges are set at various depths and the hole tested until it is certain the bridge is below the leak and then cement is squeezed under high pressure through the hole in the pipe and around the pipe. This method is very successful in the Panhandle. Another method that is very successful after the leak is found is to run a smaller string of pipe in the producing casing and cement. This is expensive, however, and the recent war and the present scarcity of pipe have produced another method. This is to run a smaller string of pipe sufficiently long to extend below the leak. A packer is placed in the pipe and set at a point just below the leak.

Another method of locating leaks in casing has been invented by Charles I. Galloup, superintendent of drilling operations for Texhoma Natural Gas Company. It is simple in operation as well as construction, but highly useful. It consists of a metal cylinder about 16 inches long with a wire-mesh cylinder attached to the lower end of the metal tube. A skirt of fabric is placed over the tube and held in place by a rubber band. A bail is placed in the upper end of this tube to afford an attachment for a measuring line. It is lowered into the well by a measuring line and when the detector passes the leak the escaping gas or water pulls the skirt into the leak and stops the descent of the detector. The depth is read on the measuring line and the detector is pulled. The leak is located and stopped temporarily in one operation.

In wells where water is causing difficulties several remedies are used, depending on whether the water is bottom-hole or top water. Intermediate water is rarely encountered in this area.

In cases of bottom-hole water, lead wool is lowered in wire baskets on the tools to the bottom of the hole. The wool is driven in a tight wedge against the formation. After sufficient wool has been driven to stop the incoming water, cement is placed on top of the wool to aid in holding back the water. Underreaming and other methods of enlarging the hole are used to effect a shoulder to prevent the upward motion of the water from displacing the plug.

Panhandle well being worked over to overcome caving condition. Operator cleaned out hole to bottom and filled with heat-treated marbles, thus eliminating need for running a liner.

Equalizing cement into the water-bearing formation is favored by many operators. The squeeze cement method also is employed, as well as the use of plastic.

Top-Hole Water

Top-hole water enters the well by one of two sources. If the casing is leaking or if the cement used around the casing shoe has failed, water will find entrance into the well. If water is coming from a leak in the casing it may be shut off by the methods mentioned above. If the water is coming from around the casing seat, cement is forced around the shoe by setting a bridge and squeezing the cement around the pipe. Liners are sometimes run and then perforated.

Since acidization has been successfully employed in the Panhandle area on limestone and dolomite formations, the methods employed will be discussed individually. Limestone is highly soluble in acid, and since the dolomite in this field contains large amounts of calcium carbonate, acid is also used effectively in dolomitic formations.

It has been found that by the introduction of acid into such formation the interlocking channels can be extended and the permeability of the reservoir can be increased by forcing acid by one means or another into the pores of the formation.

The acid being very active in limestone produces large increases of oil and gas. The practice here is to use strong concentrations of acid and displace it comparatively fast, removing it from the formation as quickly as possible.

In dolomitic formations where the action of the acid is considerably slower, it is thought wiser to slow down the displacement to let the acid remain in the formation longer. The time for removal varies from two to 24 hours at the discretion of the person in charge of the operation.

The granite wash in this area is loosely cemented by limestone. The reason for using acid in this type formation is to remove the limestone, thus enlarging the spaces between the granite-wash particles.

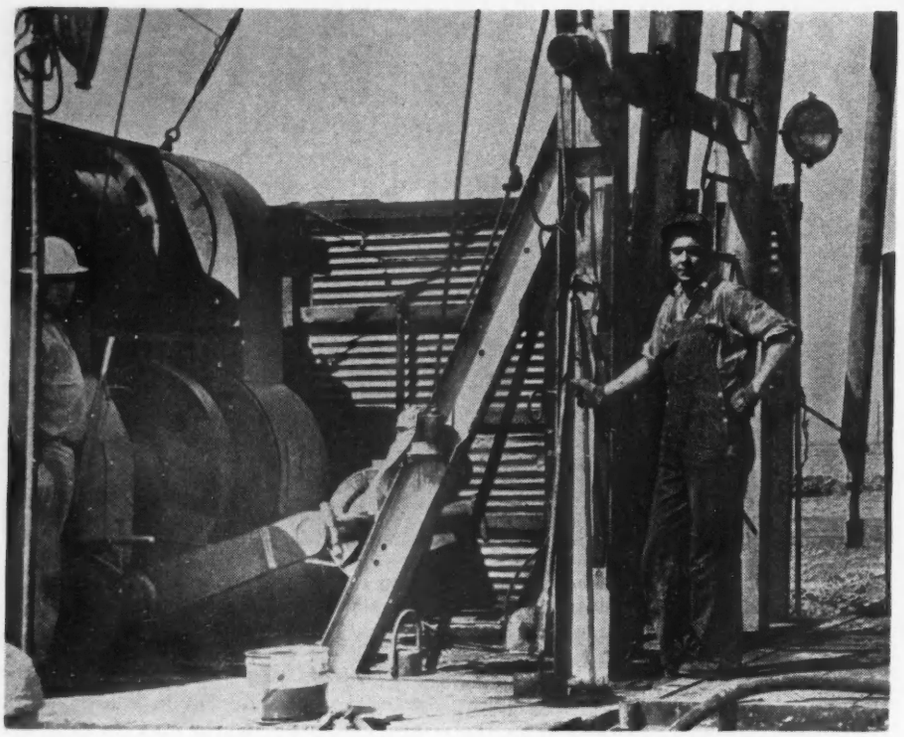
Acidizing Methods

Operators favor different methods of acidizing. Acidizing through the open casing is the most common. This is accomplished by using a compressor or oil or water to force the acid into the formation. In either case the acid is put into the well and then by compressor or fluid weight the acid is forced out into the formations.

The use of the compressor will vary with the operator. Some operators favor breaking down the formation with the compressor before the acid is dumped while others dump the acid and then displace it with the compressor. Good results are obtained by both methods.

The electric pilot and the packer are the two methods of selective acidizing employed in this area.

The packer method is accomplished by using any of the type of packers offered the industry by several of the service companies. The depth at which the packer is to be placed is first determined and then the packer is set at this point by running into the well on tubing. The hole outside of the tubing is loaded with oil for added security. The acid is then pumped into the tubing and the tubing is flushed with oil or water. The compressor is also used in this type of acidizing. The formation is broken down first and then the acid pumped, or the acid is pumped and displaced by the compressor. The compressor method is



Panhandle well being deepened after a recheck of old log revealed that additional pay could be expected at a lower level.

favored because the operator can be more positive that the packer held and that the acid went where it was intended.

The other method of selective acidizing employed in the Panhandle si by the use of the electric pilot. In acidizing, the pilot has a two-fold purpose; by its use a permeability survey is taken to assist the operator in determining which zone to treat and the acid can be confined entirely to this section.

Electric Pilot

The component parts of the electric pilot are a single conductor cable, a specially designed electrode arrangement, and a meter for determining at what position the acid is in relation to the zone to be treated.

A seating nipple is run on the bottom of the tubing and set at a predetermined depth. Oil is put in the well between the tubing and casing to hold the acid on bottom. The pilot, suspended on the conductor cable, is then run into the well and is seated in the seating nipple. The cable is attached to a drum housed within the mobile unit. By means of a split ring a current is passed to a meter on the surface. The acid is then introduced into the well through the tubing and passed into the hole through the pilot. Acid being a conductor completes a circuit and a deflection is noted on the meter at the surface. The degree of submergence of the pilot determines the acid level.

Since oil is non-conductive the interface of the oil and acid can be determined and held at any desired level by alternately pumping oil and acid. Two pumps are necessary for this operation, one to pump the acid and one to pump the oil.

If an upper zone is to be treated, the reverse of this procedure is applied. The acid is pumped into the casing and the oil is pumped into the tubing. The pilot is sometimes used in an open hole, but the use of tubing is the more general practice in the Panhandle.

To minimize corrosion of well casing, tubing, and pump equipment, the operators find it desirable to have an inhibitor mixed with the acid. Hot acid is a debatable issue in this area.

The use of explosives for increasing the flow of oil in a well has long been common practice in this area. In the past this was considered the most efficient means of increasing production, and many operators still prefer it. For certain workover jobs it has proven the only method of obtaining the desired results. This is especially true in dolomitic zones and where insoluble materials have closed the pores of the formation.

Solidified Nitroglycerin

Operators favor the use of solidified nitroglycerin since it offers a certain safety factor and also produces the same shattering effects. It is the opinion of some operators, but by no means is it unanimous, that the explosive forces of the nitroglycerin glazes the face of the formation. Recently a new explosive has been perfected and it is believed that these effects are reduced to a minimum. The safety factor of this new explosive is greater than that of the solodified nitroglycerin.

The explosives are put in the well by loading shells and placing them at predetermined depths. A time clock is set to detonate the explosives, allowing for the time consumed in packing or tamping the hole. The packing and tamping are done to direct most of the force of the explosion out into the formation.

Nitroglycerin is also used in conjunction with marble shooting and recovering pipe from wells to be abandoned. Marble shooting as an aid in reconditioning oil and gas wells is gaining more and more success. The marble shot utilizes the velocity of the explosive and directs its power through the projectiles.

The tool consists of two concentric fragile tubes. Heat-treated glass marbles, five-eighths inch in diameter, fill the annular space between the three-inch outer tube and the 1⅝-inch tube in the center which contains the explosive. The torpedo weighs 16 pounds per five-foot section. It holds two-fifths of a quart of glycerin per foot, making the total weight 22½ pounds when completely assembled. The torpedo fires 242 marbles per linear foot.

The tool is constructed to give a uniform pattern of hits. The design of six marbles surrounding each marble allows each of the seven marbles to have one point of contact with the explosive container and with each marble next to it. Upon detonation the marbles are propelled outward into the formation. As the resistance of the formation overcomes the outward thrust, the marble disintegrates with a blasting force toward the center of the well bore and removes the encrustation on the sand face.

Lowering the Torpedo Into the Well

The torpedo is lowered into the well by wire. A container long enough to cover the entire pay section can be run at one time.

Marble shooting has been successfully used to shred liners, to restore to a concentric condition damaged pipe, to reopen section of squeeze jobs, to sidetrack junk, and to remove deposits of salt and gypsum from the face of the pay section.

In the early history of the Panhandle area it was common belief that salt water would be encountered as soon as the bit reached sea-level, and most of the wells were completed above sea-level. Many of these early wells are now being deepened and large increases are obtained in many instances. After the well is deepened acid or explosives are employed by one of the methods mentioned above.

ELECTRON EYE Assists Oil Research

By Dr. CARL A. MOORE
University of Oklahoma, Norman

OPTICAL OR LIGHT microscopes are limited by the length of light waves, and magnifications about the order of 2000 are unsatisfactory. By adapting the electronic microscope to oil problems, reservoir engineers, geologists and research scientists have a field which now extends to 20,000 diameters or more.

THE optical or light microscope is now about as efficient as it is possible to construct it. The limits of the microscope are not the lack of skill on the part of the designer but rather are due to the means used for the observation, that is, to light itself.

The resolving power of a microscope is defined as its ability to discriminate between minute objects which lie very close together. In spite of various methods that may be used to increase the resolving power of a light microscope, objects separated by less than 0.1 micron (0.0001 millimeter) cannot be resolved. This limitation is an important factor in microscope research; for example, the study of viruses must be conducted with particles and separations much smaller than this, and the study of colloids necessitates greater resolving power than that possible with the light microscope.

The functioning of the electron microscope is based on the fact that it is possible to secure highly magnified images by combining two or more electronic "lenses" into an "electron optical" system. The great advantage of this microscope is the fact that the magnification is no longer limited by the wave length of visible light. Theoretically, the electron microscope should be capable of resolving powers as small as atomic dimensions. In actual practice, however, the microscope has not as yet been perfected to that extent. Nevertheless, by taking the useful limit of a light microscope as a magnification of 2000 diameters, a magnification value of over 100,000 diameters is practical with the present electron microscope.

Figure 1 is a comparison of the optical microscope with the electron microscope showing equivalent parts; magnetic fields are equivalent to lenses; both have specimen levels; both have photographic plates for pictures. For comparison purposes, the electron microscope is diagrammed upside down.

A simplified drawing of the RCA compound magnetic electron microscope, type EMB, is shown in Figure 2. Focusing is accomplished by varying the lens power. The specimen mount is the movable stage. Being inside the vacuum portion of the microscope, motion is achieved by means of fine screws and a metal flexible bellows.

The electron beam is concentrated on the specimen by the magnetic field produced in the condenser-lens coil. After passing through the specimen, the electrons are focused by the objective-lens coil into an intermediate image, and the projection-lens coil produces a further magnified image on the fluorescent screen in the final viewing chamber.

To facilitate the initial adjustment of the specimen, a port is provided for viewing the intermediate image on a fluorescent screen close to the plane of the projection-lens coil. The relatively low magnification of this image makes it easy to select the most interesting part of the specimen and to move it into position to be magnified further by the projection-lens coil.

Six observation windows enable a number of spectators to view the image simultaneously. The selected field of view is chosen, magnification adjusted to the desired value, and a photographic record may be made by raising the fluorescent screen and allowing the electrons to strike a photographic plate below the screen, which plate is carried in a holder in the vacuum system of the microscope.

Magnifications of 1000 to 20,000 diameters are thus obtainable, and the definition in the photographs is sufficiently clear to allow further optical enlargement to obtain full useful magnification.

In the electron microscope an area approximately 0.01 millimeter square is

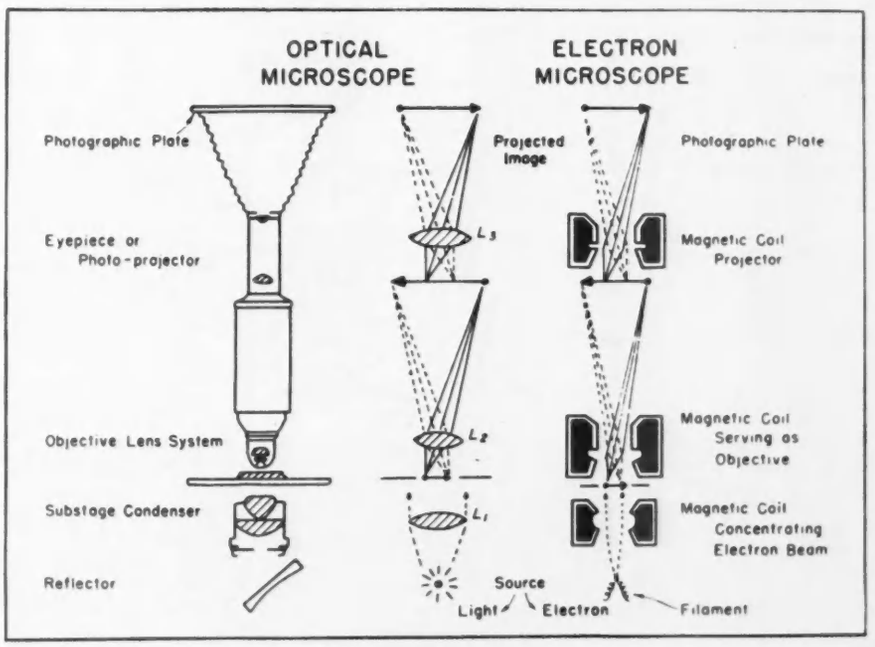


FIGURE 1

enlarged to the desired magnification. Thus, to photograph an area 1 mm. square would require 10,000 exposures. To scan this area, however, takes only a few moments because of the maneuverability of the instrument.

For working with such small areas a special specimen-mounting technique had to be devised. The RCA people in Camden, N. J., mount specimens on a 400-mesh screen. This screen is dipped into a solution of collodion which dries quickly, leaving a strong film, approximately one micron (0.001 mm.) thick, between the individual wires.

The material for study may be placed on the collodion film in one of several ways: (1) manually, under high-power binoculars; (2) precipitated from solution onto the screen; (3) by passing the screen coated with collodion through a culture of the material; (4) by placing a drop of material suspended in a liquid onto the screen.

No wet or living tissue can withstand the high vacuum of 10^{-4} to 10^{-5} mm. of mercury in the electron microscope. However, this microscope is being used extensively in biological studies on materials ranging in size from organs of animals and insects downward through the bacteria and to the viruses, and even to large molecules. The material in turn must be thin enough to allow the passage of electrons through it. Some materials deteriorate when subjected to the intense electron bombardment, and some materials may heat up during this bombardment. Owing to the high vacuum this heat can not be transmitted or conducted away from the subject.

Possible Geological Uses of Electron Microscope

A. Identification and correlation of clays

Quoting Hillier (1946), "... particles of various types of clay have probably been subjected to more examination by means of the electron microscope than any other type of material." Some clays are composed of grains of the order of some 50 angstroms thick, and a few angstroms wide. Studies in the nature and correlation of such minute particles in the electron microscope is dependent upon characteristic shapes and not on chemical combinations.

In Decatur County, Georgia, there is a clay that is used extensively in laboratories and refineries for filtering purposes. This is called Attapulgus Clay, so named for a nearby town. Chemical analyses of this clay show it to be chiefly montmorillonite, a hydrous aluminum silicate, but the individual microcrystalline masses can not be identified or resolved under the best light microscope. Figure 3 is an electron microscope picture of this clay, showing an abundance of bundles and masses of minute fibers. These fibers are the so-called microcrystalline masses that can not be identified or resolved under the polarizing microscope.

Infusorial earth is described as a "siliceous earth made up largely of siliceous fragments of Infusoria, used as fulling material and as a filtering and absorbing agent." Figure 4 is an electron microscope picture of this material, showing fibers very similar to the Attapulgus Clay. The similar shapes of constituent parts of these two materials attest to their similar physical properties.

Clays might lend themselves to study and identification in the electron microscope along the following lines:

(1) Minute crystals of rutile have been identified in titanium-rich clays. These crystals are too small to be identified under a light microscope. This would lead to a study of the sub-microscopic mineralogy and crystallography of clays.

(2) The nature and occurrence of the clay material in oil-producing sandstones is a study in itself. Recently, a micaceous flake about one-micron in length, was obtained from an oil sand and photographed in the electron microscope (Bates, Gruver, and Yuster, 1946). The nature and abundance of such clay materials might be a valuable aid in the detailed correlation of oil sands, in the study of reservoir behavior, and in setting up water-flooding projects in essentially depleted oil fields.

(3) Structural details of clays, pertaining to possible physical and physiochemical properties of the clays, should lend themselves to study in the electron microscope.

(4) Presence of submicroscopic organic forms too small to be identified, or even noted, under a light microscope.

(5) Studies of the response of clays to the high vacuum in the electron microscope, and changes due to the electron bombardment, and subsequent heating of the samples.

B. Studies of Crude Oil

It will be necessary to develop a technique for studying crude oils in the electron microscope. A specimen of crude oil was mounted in the usual manner on collodion film, and a monotonous gray field was seen, except for one object or group of objects (Figure 5). This was composed of a number of oval bodies; some of these are seen to be solid, while others appear to be breaking up. It is possible that this object was not able to withstand the high vacuum and the electron bombardment in the electron microscope, and the photograph caught the material in the process of disintegration.

A possible approach to the study of crude oils in the electron microscope may be outlined as follows:

(1) Study all foreign substances in the oil and in the extracts that it is pos-

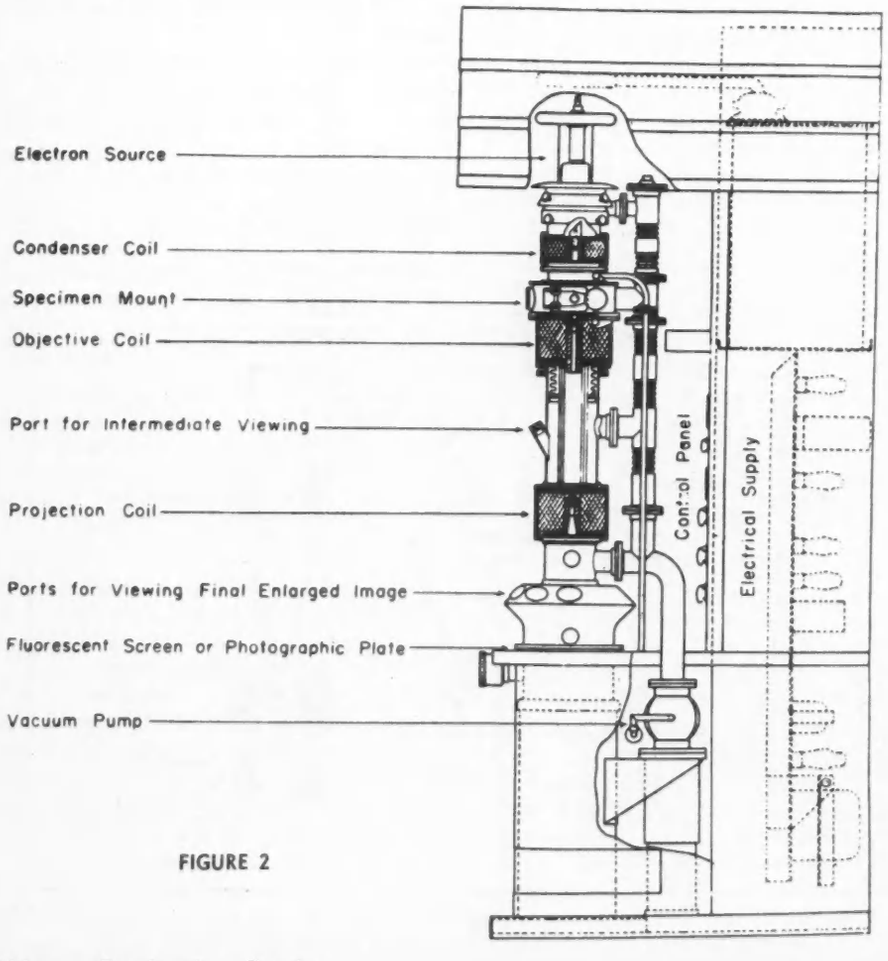


FIGURE 2

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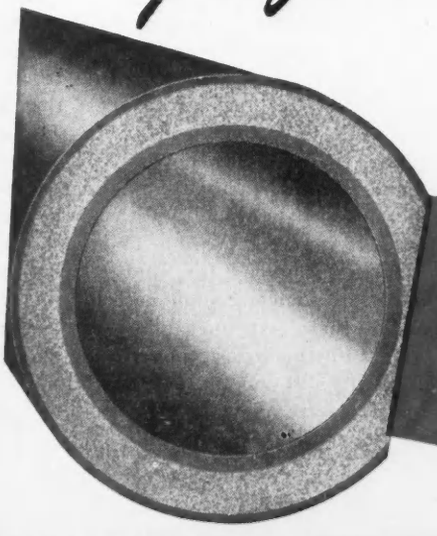

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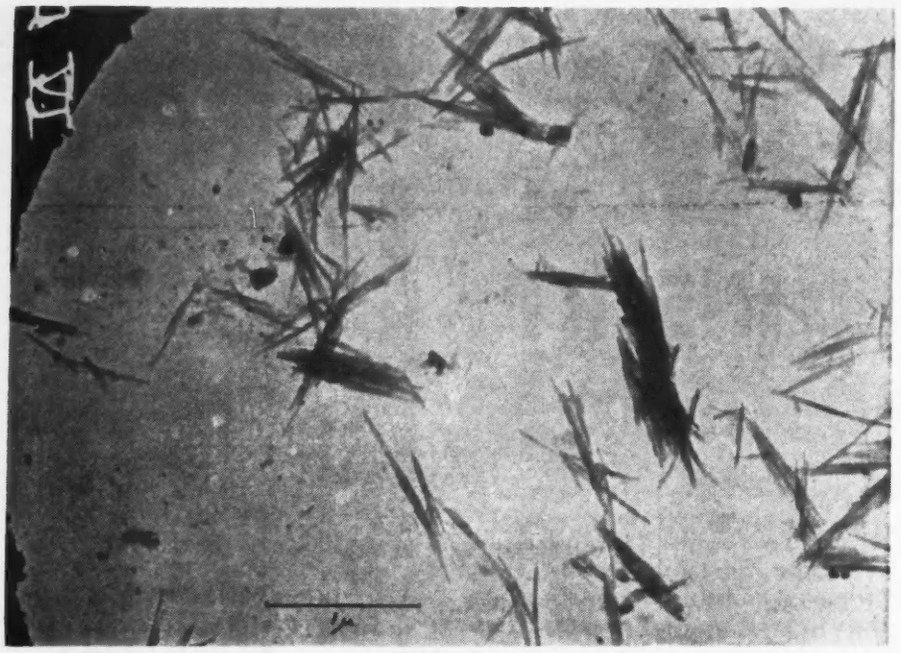

FIGURE 3

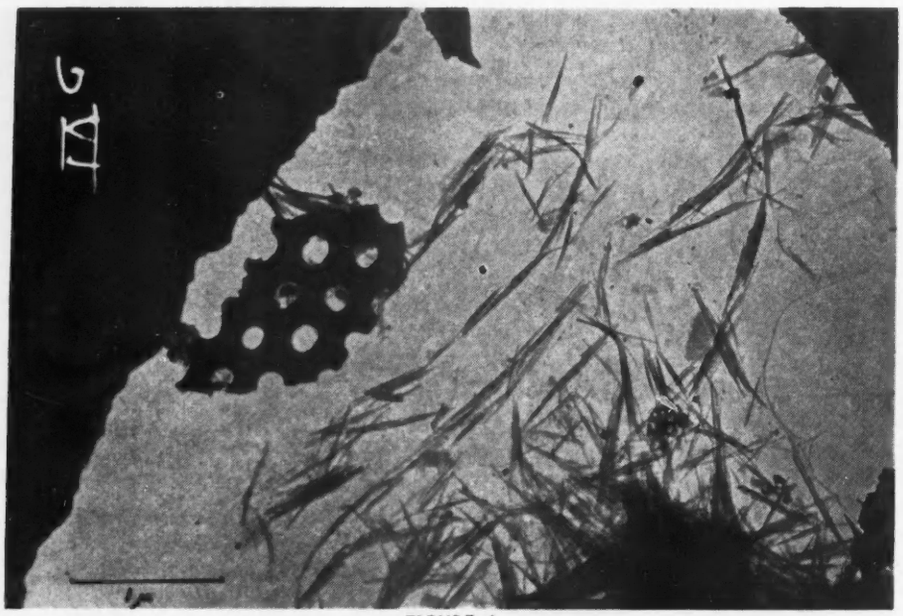

FIGURE 4

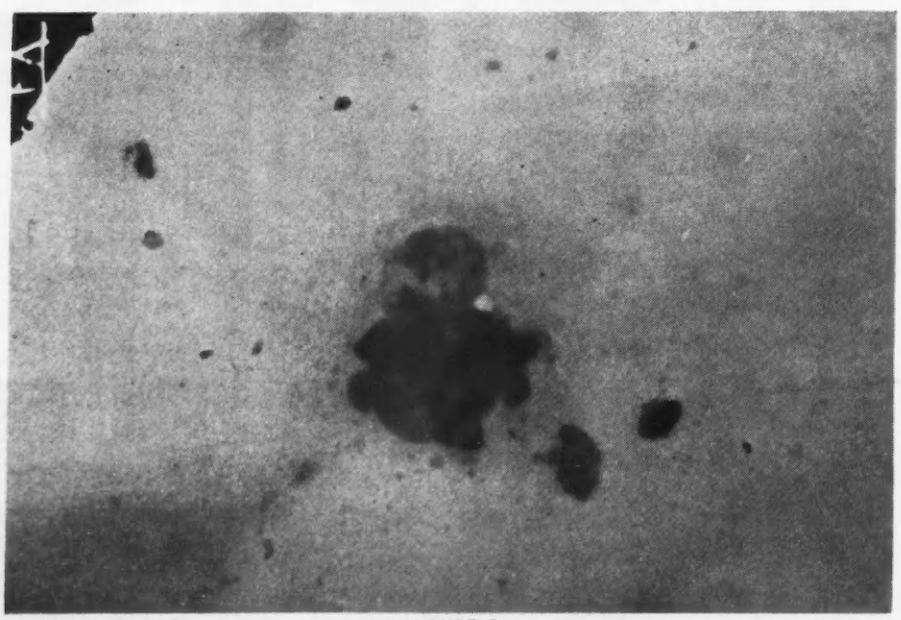

FIGURE 5

sible to prepare for study in the microscope.

(2) Note and identify bacteria in the oils and in the extracts.

(3) Study the nature of coloring material in asphalts. Is this color due chiefly to molecular combinations, or to the presence of foreign materials?

(4) Study the behavior of the oil and extracts during preparation, and note the reactions to the high vacuum and to the electron bombardment.

(5) The RCA engineers and research physicists have photographed what they believe to be giant molecules in the electron microscope. Perhaps actual molecular differences may be found in crude oils, in the extracts, and in the various fractions, that may be used for correlation.

C. Paleontological Studies

Generally speaking, paleontological specimens are too large for study in the electron microscope. However, it should be valuable in studying details of fossils too small for study under a light microscope. Examples are diatoms, spores, algae, and some protozoans. A comparison of diatom shells photographed with a light microscope and the electron microscope would show that under the light microscope the number and arrangement of the perforations can hardly be determined, while the electron microscope indicates clearly the detail, arrangement, and number of perforations in each case.

Conclusion

The electron microscope has opened up a new realm of research and endeavor. It is being adapted to a great number of scientific fields both for research and for industrial purposes. Future developments should increase the resolving power far beyond the best that is available today, but, conversely, this increase in resolving power will be one of the limiting factors of the microscope because by working with very minute objects it is not possible to mount particular specimens for study. However, most geological techniques do not require these extremely high magnifications. Further researches in strictly geological fields will have to be limited to particular problems where usefulness of the microscope can be fully utilized.

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pH Determination in Condensate Well Waters

By D. A. SHOCK
Corrosion Research Chemist, University of Texas

BY MODIFYING a standard dew point apparatus, a pressure chamber has been constructed so that the pH of wellhead water can be estimated at wellhead pressures ranging up to 4000 pounds per square inch. The apparatus has been successfully operated in four fields, making several dozen determinations without failure on pressures up to 2500 psi and temperatures to 170° F.

WORK done by the Natural Gasoline Association of America's Corrosion Research Project Committee has proven that the major cause of corrosion in high pressure condensate wells is acid attack.[1,2] The acids responsible for the attack were found to be carbonic acid and the lower molecular weight fatty acids in the water phase. Both field and laboratory observations have given conflicting evidence as to the importance of each and both of these corrodents acting at wellhead conditions. It was evident that a means of determining acidity in the well at well conditions would give valuable data.

Carlson's work on determining pH of well waters under pressures of CO_2, which were similar to the partial pressures of CO_2 in the well, by use of color indicators in pressure bottles, marked the first step in estimating the pH under wellhead conditions.[3] This work showed that pH values low enough to attack iron could be obtained from CO_2 under partial pressures existing in the wells in samples of produced well water. A high pressure gauge glass was also designed to carry the applicator into the field. Taking Carlson's experience into the field, a different apparatus was used with good results.

The possibility of using a dew point apparatus was investigated and, with a few simple alterations, the apparatus was converted to this application. The dew point apparatus consists of a stainless steel pressure block with approximately ¾-inch hole drilled and tapped in two opposite sides. One side is fitted with a lucite window which is held in place by a lug, the lucite acting as its own sealing gasket when it is tightened against a shoulder in the block. The other side has a mirror backed with a propane chilling arrangement. This was taken out and replaced by a lucite window identical to that on the other side. It was thus possible to see through any clear liquid which was run into the vessel. An outside mirror hinged on the side of the block and set at an angle enabled the operator to look through the two windows with little danger if the window should give way. A diagrammatic sketch is shown in Figure 1. Several dozen determinations have thus far been made with no failures in this apparatus.

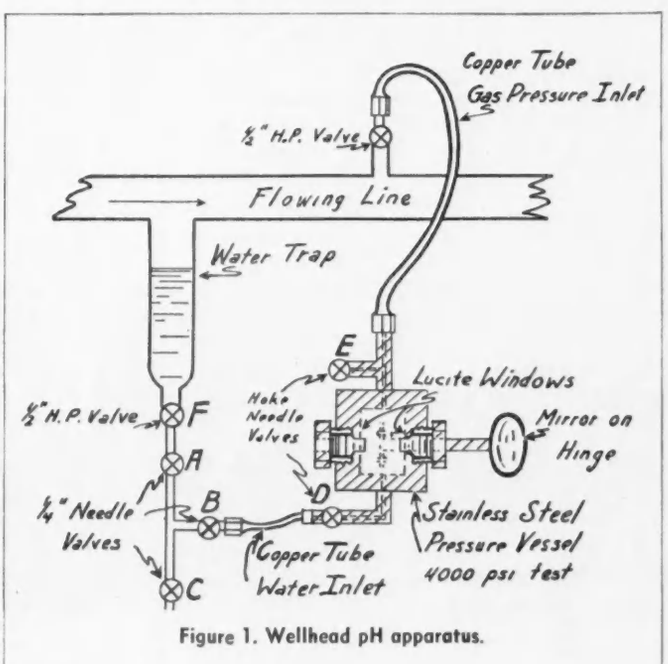

Figure 1. Wellhead pH apparatus.

Method of Determination of pH

The technique worked out for determining pH is as follows:

(1) Connect the modified dew point apparatus into the well, well lines, or across a high pressure separator similar to the arrangement shown in Figure 1. A tee connection with three valves is connected on the water trap and a short length of copper tube connected to the bottom inlet of the stainless steel block. The top of the stainless steel block is connected with copper tubing to the line pressure, preferably at a pressure at, or slightly below, that on the water trap, i.e., slightly downstream.

(2) Tighten connections and pressure test the apparatus. This is done by closing needle valves B, C, and Hoke needle valve E and testing the pressure valve with gas pressure; then opening ½-inch HP valve F, and needle valve A, and testing the tee with water pressure.

(3) Flush out apparatus with water under near well pressure. It had been noted by Carlson that the iron could take up enough acidic constituents to alter the pH value considerably. This was found to be a definite factor in the wells of 1 percent CO_2 content. The effect was decreased by exposing the iron surface from the trap to the copper inlet tube with as much water as possible so that the take up reached a minimum. To accomplish this, valve C was cracked with A and F open and water allowed to drip out. Valve C was closed, B and D opened, and water allowed to run into the pressure vessel until full. The water ran in by gravity when the gas was below water pressure; when it was not, valve E was cracked very slightly to allow liquid flow into the pressure chamber. When the vessel was full, A was closed and, by regulating the gas pressure, the liquid was forced out valve C into the air. This was repeated several times.

(4) Add indicator. In the final purging step, the water is blown out of vessel so that line from valve D to B to C is filled with gas. These valves are closed under gas pressure.

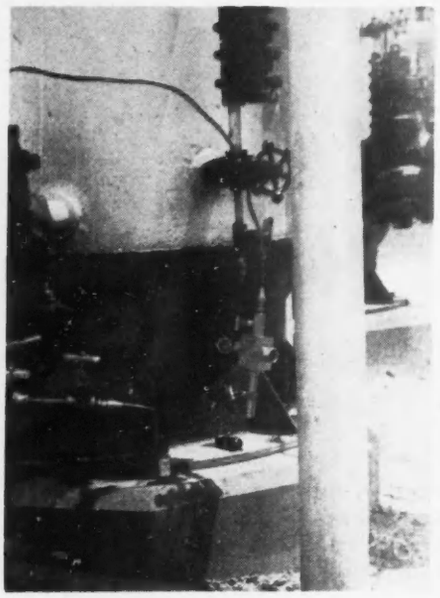

Figure 2. Apparatus in a high pressure separator.

Figure 3. Apparatus in use on christmas tree.

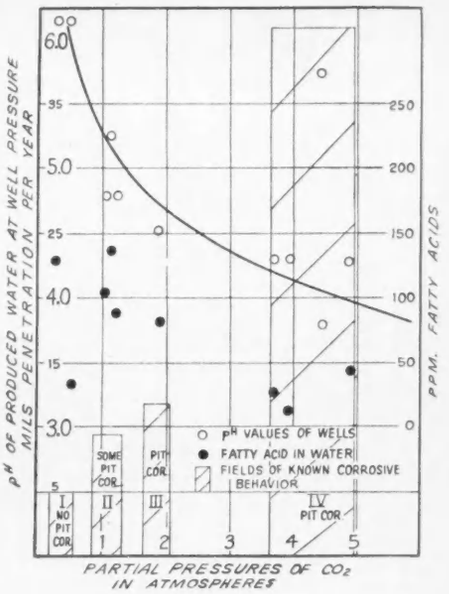

Figure 4. Well corrosion—pH correlation curve.

The ½-inch HP valve on the gas inlet line is closed and pressure released from the vessel from valve E. The gas inlet copper tube connection is then broken and 1 cc of indicator solution injected into the vessel with an eye dropper. The vessel is connected, valve E closed, and put on line pressure by opening ½-inch HP gas valve. Water is run into line in tee by opening A and bleeding out a small amount at C filling the line. Valve B and then valve D is opened slowly letting the water run into the chamber slowly mixing with the indicator.

(5) Determine pH by color comparison. The volume of the vessel is approximately ten cc. A series of standard buffer solutions in steps of 0.5 pH from 3.0 to 6.5 pH were made up previously. Ten cc of these buffer solutions were placed in a test tube, adding one cc of indicator. The diameter of the test tube was approximately equal to the distance through the pressure chamber. The color is compared with that seen in the mirror through the lucite windows. If the pH is outside the indicator range, the determination is repeated in the next range until a color match is obtained. The ranges and indicators were as follows:

Indicators	pH Range
Bromphenol Blue	3.00—4.6
Bromcresol Green	3.8—5.4
Methyl Red	4.4—6.0
Chlorphenol Red	5.2—6.8

Four fields were selected on the basis of their corrosive character as determined by coupon test and observed operation. Table 1 shows the results from various wells in the four fields, comparing the partial pressure of CO_2 and the total organic acid concentration to the pH values determined. Figure 4 shows a graphic interpretation of these results along with representation of the corrosive character of the four fields. It is evident that a pH value taken at atmospheric conditions does not reflect the pH in the well. In the four fields studied, there is a clear trend for the pH values to decrease with increase in partial pressure of CO_2.

These fields also show progressively increasing corrosion rates and pit attack as the partial pressure of CO_2 increases. The values found for the total organic acid content do not seem to show a definite trend relating either to rate of attack or wellhead pH.

The modified dew point apparatus used in these series of tests gave satisfactory results within the limits of expected error. Field operation showed the apparatus to be easily adaptable to most standard equipment and readings could be made with a minimum of interference with well operation. There were no failures in the apparatus due to excessive pressure.

The well pressure pH values demonstrate that carbonic acid concentrations are largely responsible for the severely corrosive conditions found in the fields studied. The corrosive conditions found in Field I would be expected to result from the organic acid concentration alone. The organic acids seem to have reacted with the tubing by the time they reach the wellhead so that little effect is noted from them when a pH determination is made of the fresh water sample at atmospheric pressure. The water samples show a definite tendency to decreas in pH value on standing since the iron hydrolyzes and organic acid is freed. The results show why much of the pH data taken on well waters reflect no correlation with the corrosion taking place in the well. It is believed that the technique used demonstrates a relatively simple method of pH determination which would more closely reflect the potential corrosiveness of a well.

TABLE I

Field	Well	Percent CO_2	P	T	Atms CO_2 pp.	Total ppm Org. Acid as Propionic	Color pH @ Well P	Color pH @ Atms P
I	A	0.3	1110	99	0.23	123	6.0	6.2
I	B	0.5	1300	135	0.44	25	6.0	6.2
II	A	0.7	2235	151	1.07	104	4.5–5.0	5.5
II	B	0.7	2385	156	1.14	135	5.0–5.5	5.6
II	C	0.7	2425	172	1.16	90	5.0–(4.8)	5.6
III	A	1.2	2150	160	1.75	85	4.5	6.0
IV	A	2.6	2000	174	3.50	22	4.0–4.5	6.1
IV	B	2.5	2600	145	4.40	225	3.6–4.0	5.6
IV	C	2.5	2850	160	4.90	7	4.0–4.5	5.4
IV	D	2.5	2300	165	3.45	45	4.0–4.5	5.6

ACKNOWLEDGEMENT

The author wishes to express his appreciation to the Corrosion Research Project Committee of the Natural Gasoline Association of America for its financial and technical support in carrying on this work, and to T. S. Bacon of the Lone Star Gas Company who suggested the use of and furnished the dew point apparatus.

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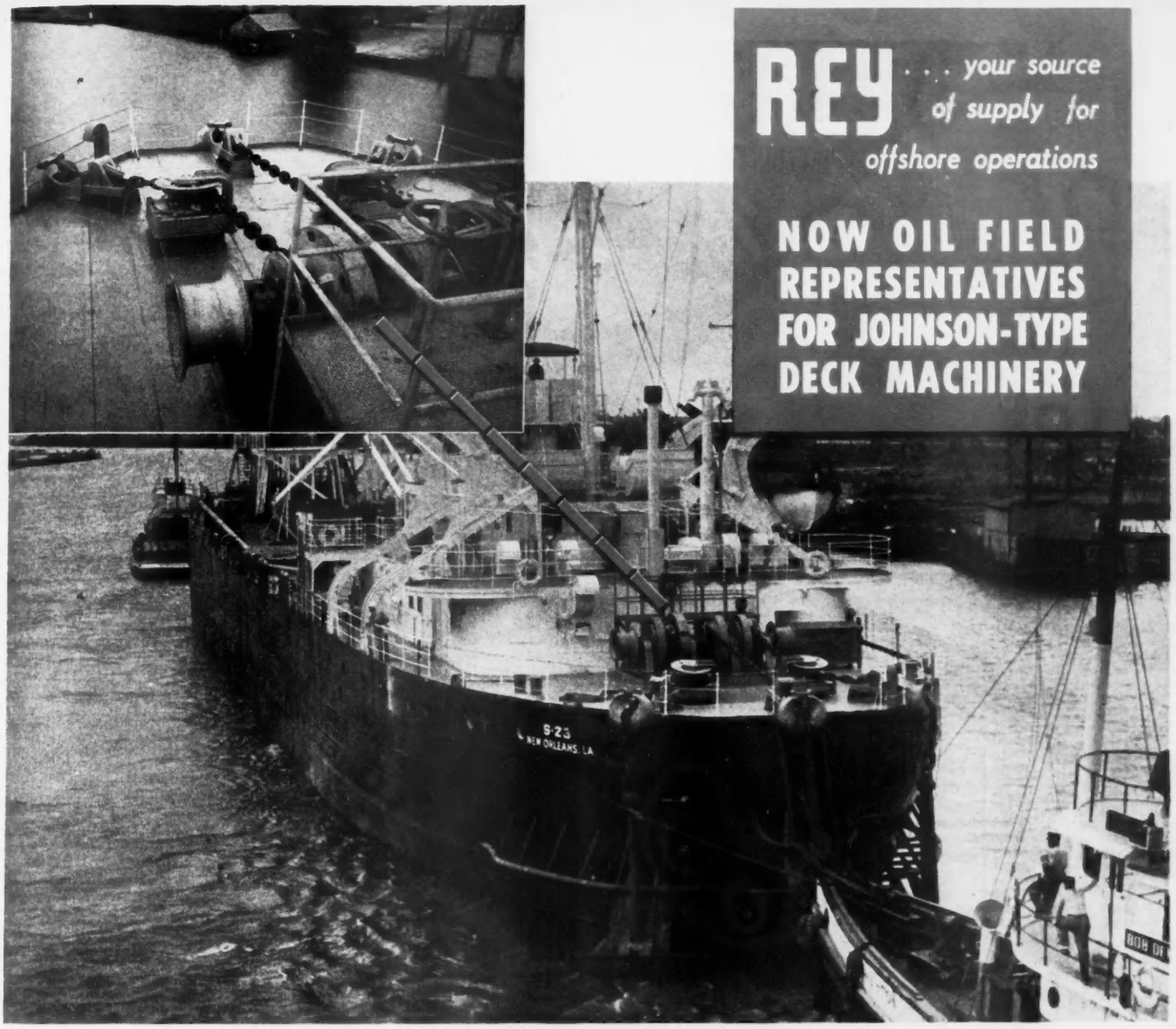

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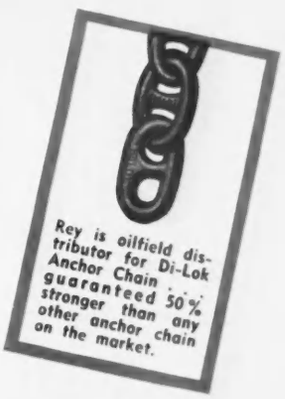

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EFFECT OF ADDED *Nitrogen* ON COMPRESSIBILITY OF *Natural Gas*

By C. K. EILERTS,
H. A. CARLSON and
N. B. MULLENS

Part 2

Compressibility of Nitrogen and Natural-Gas Mixtures

THE compressibility characteristics of a nitrogen and natural-gas mixture containing 7.907 mole percent added nitrogen as determined in the equilibrium cell are illustrated in Figure 9. In carrying out the tests the separator gas was introduced into the cell first, and measurements were made to determine the number of moles of hydrocarbons in the sample. The compressibility data previously obtained on the separator gas and a measurement of the volume of the sample at the pressure and temperature of the cell were all that was needed to compute the volume of the gas at 14.4 psia and 75° F. The volume of the nitrogen added to the gas in the cell was measured under pressure in a separate calibrated vessel and then was displaced by mercury from the measuring vessel into the equilibrium cell. The mass and the molal concentration of the nitrogen that was added to the natural gas in the cell were readily computed from the volumes (at atmospheric pressure) of the constituent gases. As indicated in Table 1, the 7.907 mole percent added nitrogen does not include the nitrogen naturally present in the gas in a concentration of 0.69 mole percent.

The measurements of the volumes of the nitrogen and natural-gas mixture as

TABLE 3
Properties of Mixture Containing 7.907 Mole Percent (11.350 Mass Percent) Added Nitrogen

Pressure, Lb. per Sq. In. Abs.	Specific Volumes (v, cu. ft. per lb.) Compressibility Factors (Z) and Additive Volume Correction Factors (W) at Indicated Temperature								
	32° F.			70° F.			100° F.		
	v	Z	W	v	Z	W	v	Z	W
5000	0.05114	0.9443	0.9911	0.05605	0.9607	1.0010	0.06011	0.9750	1.0046
4750	.05217	.9152	.9919	.05741	.9347	1.0011	.06178	.9519	1.0047
4500	.05331	.8858	.9926	.05894	.9091	1.0010	.06368	.9296	1.0055
4250	.05460	.8568	.9931	.06070	.8842	1.0014	.06579	.9071	1.0053
4000	.05610	.8287	.9943	.06271	.8599	1.0016	.06831	.8864	1.0063
3750	.05784	.8010	.9947	.06510	.8368	1.0032	.07127	.8670	1.0073
3500	.05987	.7739	.9962	.06799	.8157	1.0056	.07482	.8495	1.0083
3250	.06240	.7489	.9984	.07149	.7964	1.0073	.07910	.8340	1.0101
3000	.06551	.7258	1.0011	.07583	.7798	1.0093	.08436	.8210	1.0109
2800	.06860	.7093	1.0042	.08014	.7691	1.0115	.08954	.8133	1.0118
2600	.07244	.6955	1.0074	.08539	.7610	1.0124	.09577	.8078	1.0122
2400	.07732	.6853	1.0115	.09195	.7565	1.0143	.10341	.8052	1.0124
2200	.08368	.6799	1.0172	.10026	.7561	1.0165	.11294	.8060	1.0131
2000	.09204	.6797	1.0218	.11080	.7596	1.0162	.12488	.8102	1.0128
1800	.10337	.6871	1.0244	.12458	.7687	1.0168	.14022	.8188	1.0135
1600	.11889	.7024	1.0253	.14274	.7829	1.0150	.15989	.8299	1.0108
1400	.14062	.7270	1.0238	.16691	.8010	1.0116	.18589	.8443	1.0096
14.4	18.75	.9972	1.0000	20.22	.9979	1.0000	21.37	.9982	1.0000
	130° F.			160° F.			190° F.		
	v	Z	W	v	Z	W	v	Z	W
5000	0.06430	0.9899	1.0049	0.06861	1.0051	1.0038	0.07297	1.0196	1.0034
4750	.06629	.9695	1.0054	.07093	.9872	1.0048	.07561	1.0037	1.0048
4500	.06854	.9496	1.0059	.07350	.9690	1.0050	.07852	.9874	1.0053
4250	.07108	.9301	1.0061	.07646	.9521	1.0056	.08184	.9721	1.0059
4000	.07404	.9119	1.0068	.07985	.9358	1.0060	.08567	.9577	1.0062
3750	.07753	.8952	1.0076	.08385	.9213	1.0066	.09015	.9448	1.0065
3500	.08171	.8805	1.0083	.08863	.9089	1.0078	.09544	.9335	1.0070
3250	.08672	.8678	1.0094	.09428	.8978	1.0083	1.0171	.9238	1.0070
3000	.09283	.8575	1.0101	.10116	.8891	1.0085	.10931	.9164	1.0074
2800	.09880	.8518	1.0110	.10776	.8841	1.0086	.11655	.9120	1.0073
2600	.10591	.8479	1.0108	.11560	.8806	1.0086	.12511	.9090	1.0076
2400	.11450	.8461	1.0103	.12504	.8793	1.0086	.13535	.9078	1.0080
2200	.12503	.8459	1.0087	.13652	.8800	1.0086	.14770	.9081	1.0081
2000	.13818	.8509	1.0101	.15066	.8829	1.0085	.16276	.9097	1.0081
1800	.15469	.8573	1.0093	.16827	.8875	1.0079	.18140	.9125	1.0073
1600	.17575	.8658	1.0079	.19066	.8938	1.0069	.2051	.9171	1.0062
1400	.2034	.8766	1.0064	.2200	.9024	1.0056	.2360	.9234	1.0047
14.4	22.52	.9986	1.0000	23.68	.9989	1.0000	24.83	.9991	1.0000
	220° F.			250° F.			280° F.		
	v	Z	W	v	Z	W	v	Z	W
5000	0.07735	1.0331	1.0037	0.08168	1.0448	1.0044	0.08594	1.0547	1.0034
4750	.08025	1.0182	1.0046	.08481	1.0306	1.0044	.08933	1.0415	1.0035
4500	.08349	1.0036	1.0053	.08833	1.0169	1.0049	.09314	1.0288	1.0038
4250	.08715	.9894	1.0053	.09235	1.0041	1.0052	.09748	1.0169	1.0040
4000	.09139	.9765	1.0053	.09697	.9923	1.0054	.10244	1.0058	1.0043
3750	.09632	.9648	1.0057	.10236	.9820	1.0058	.10820	.9959	1.0047
3500	.10211	.9546	1.0059	.10862	.9726	1.0055	.11490	.9871	1.0049
3250	.10892	.9456	1.0057	.11601	.9646	1.0054	.12279	.9796	1.0048
3000	.11715	.9388	1.0061	.12479	.9577	1.0051	.13218	.9733	1.0050
2800	.12495	.9346	1.0064	.13313	.9537	1.0054	.14104	.9694	1.0050
2600	.13415	.9317	1.0065	.14293	.9507	1.0055	.15140	.9662	1.0054
2400	.14512	.9304	1.0066	.15452	.9487	1.0055	.16358	.9636	1.0056
2200	.15825	.9300	1.0066	.16836	.9476	1.0055	.17813	.9619	1.0055
2000	.17422	.9308	1.0068	.18519	.9475	1.0052	.19581	.9612	1.0055
1800	.19394	.9325	1.0064	.2060	.9485	1.0049	.2176	.9615	1.0050
1600	.2189	.9357	1.0053	.2322	.9506	1.0040	.2451	.9625	1.0038
1400	.2514	.9402	1.0038	.2663	.9537	1.0027	.2805	.9640	1.0019
14.4	25.98	.9993	1.0000	27.13	.9995	1.0000	28.28	.9996	1.0000

Note: Value of gas constant for 1.0 pound of gas is—

$$b = \frac{Pv}{ZT} = 0.55085 \frac{\text{lb. per sq. in. abs. x cu. ft. per lb.}}{\text{°F. abs.}}$$

a function of pressure and temperature were made by means of the equilibrium cell in the same way that the volumes of the separator gas were measured. At the conclusion of the work at high pressures, the nitrogen and natural-gas mixture was transferred from the cell to the 12-liter glass flask and its volume determined at approximately atmospheric pressure, and from the datum obtained the gas constant b was found to equal 0.55085. The relation between volumes of the gas mixture under high pressures and under atmospheric pressure was corroborated by test results obtained on gas mixtures of other added-nitrogen concentrations as will be shown later in this report.

The values of the function Pv/T represented by the curves of Figure 9 and used to compute the values of v and Z shown in Table 3 are estimated to be subject to a precision uncertainty of less than $\pm$ 0.03 percent.

The values of the compressibility factor Z shown in Table 3 are experimental values determined for the mixture of natural gas and added nitrogen. The relation $W = Z/Z_a$ (equation 11) was used in computing the additive volume correction factors W compiled in Table 3. The additive compressibility factor Z_a required for the computation was evaluated by means of equation 7. The required compressibilities of nitrogen at the given pressures and temperatures were taken from Table 5 and from Figure 14, the origin of which will be discussed later in this report.

Actual Values

The experimentally determined values of compressibility factor Z and factors Z_a computed on an additive basis for the mixture containing 7.907 mole percent nitrogen are shown graphically in Figure 10. Equation 7 and data taken from Tables 3 and 5 were used in computing values of factors Z_a for drawing the dashed curves. In general, the experimentally determined or actual compressibility factors are greater than the factors computed on an additive basis. Values of additive volume correction factor W are greater than unity, which means that the volume of the mixture of natural gas and nitrogen at a given pressure and temperature is greater than the sum of the separate volumes of natural gas and nitrogen at the same pressure and temperature. For example, at 3000 pounds per square inch absolute and 130° F. the actual volume of one mole of a mixture containing 7.907 mole percent nitrogen is 1.01 percent greater

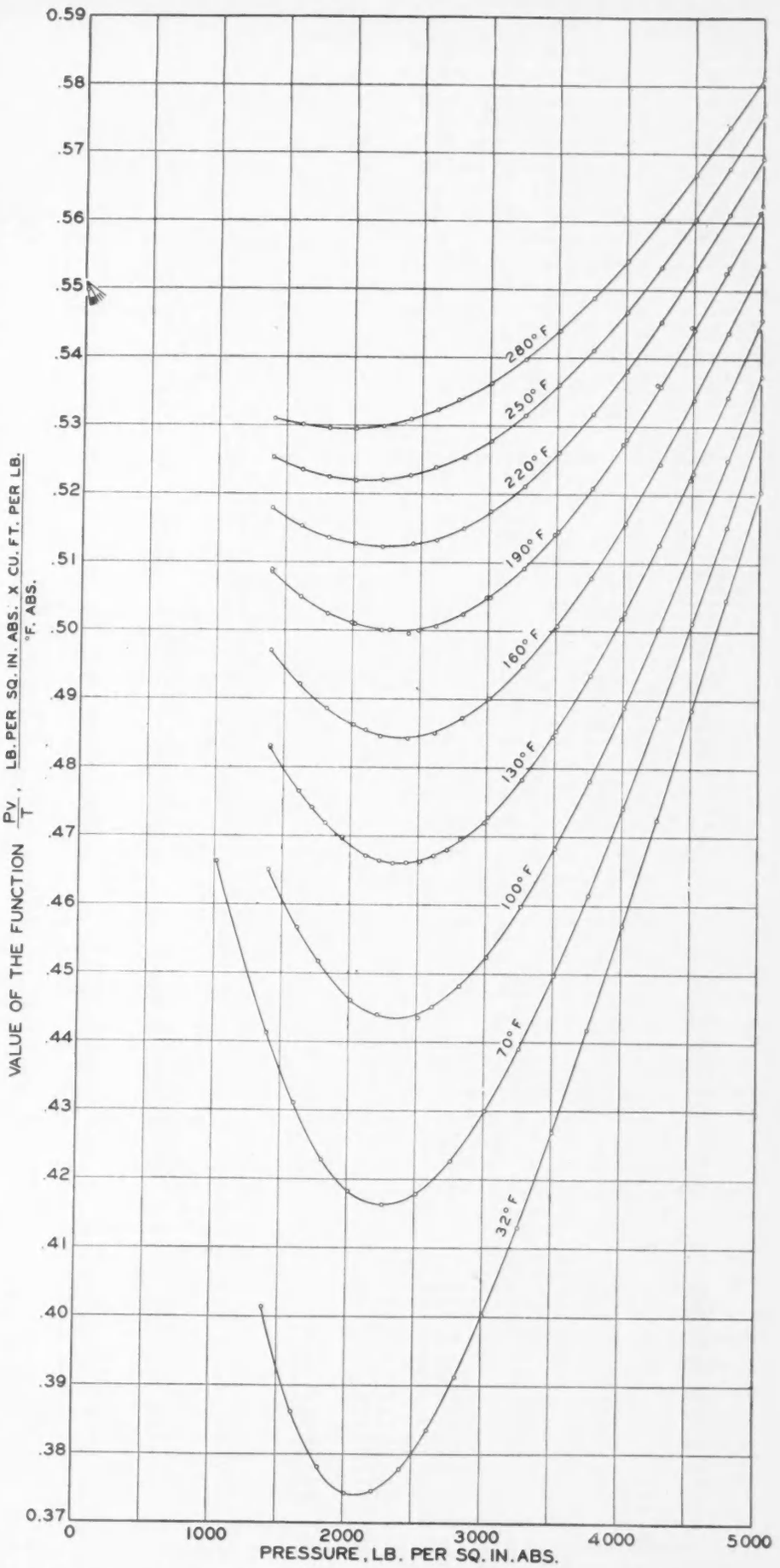

FIGURE 9. Specific volume data for mixture containing 7.907 mole percent added nitrogen.

(W = 1.0101, Table 3) than the sum of the volumes of 0.07907 mole of nitrogen and 0.92093 mole of the separator gas at the same pressure and temperature.

The compressibility characteristics of a mixture containing 18.280 mole percent added nitrogen as determined in the equilibrium cell are indicated in Figure 11. The procedures followed in determining the compressibility characteristics of this mixture were the same as those carried out with the mixture containing 7.907 mole percent added nitrogen. The gas constant b of the mixture was found to have the value 0.52498. It is estimated that the values of the function Pv/T represented by the curves of Figure 11 and used to compute the values of v and Z shown in Table 4 are subject to a precision uncertainty of less than 0.03 percent.

The experimentally determined and the computed additive values of the compressibility factors for the mixture containing 18.280 mole percent added nitrogen are illustrated in Figure 12 and compiled in Table 4, where it is again apparent that the volumes of the mixture of nitrogen and natural gas are greater than the sum of volumes of the constituent gases at the same pressure and temperature. For example, at 3000 psia and 130° F. the volume of the mixture is 1.90 percent greater than the sum of the volumes of the separate constituent gases at that pressure and temperature. The compressibility characteristics of nitrogen and natural-gas mixtures containing more than 18 mole percent nitrogen were not determined at pressures up to 5000 psi in the temperature range 32° to 280° F. However, values of additive volume correction factor W were determined for mixtures containing nitrogen in concentrations up to 56.23 mole percent at 1400 psia and 130° F. The resultant data are illustrated in Figure 13.

TABLE 4

Properties of Mixture Containing 18.280 Mole Percent (25.013 Mass Percent) Added Nitrogen

Pressure, Lb. per Sq. In. Abs.	Specific Volumes (v, cu. ft. per lb.) Compressibility Factors (Z) and Additive Volume Correction Factors (W) at Indicated Temperature								
	32° F.			70° F.			100° F.		
	v	Z	W	v	Z	W	v	Z	W
5000	0.05025	0.9736	0.9951	0.05498	0.9887	1.0035	0.05894	1.0031	1.0079
4750	.05144	.9467	.9973	.05646	.9647	1.0048	.06065	.9806	1.0079
4500	.05276	.9199	.9995	.05812	.9406	1.0055	.06262	.9591	1.0090
4250	.05422	.8928	1.0011	.05999	.9170	1.0065	.06491	.9390	1.0106
4000	.05587	.8660	1.0027	.06216	.8942	1.0076	.06752	.9193	1.0120
3750	.05782	.8401	1.0040	.06473	.8730	1.0103	.07058	.9009	1.0137
3500	.06014	.8156	1.0073	.06780	.8535	1.0136	.07427	.8848	1.0158
3250	.06299	.7932	1.0116	.07156	.8364	1.0173	.07865	.8701	1.0182
3000	.06642	.7721	1.0156	.07608	.8210	1.0201	.08406	.8584	1.0204
2800	.06983	.7576	1.0202	.08058	.8115	1.0236	.08930	.8511	1.0222
2600	.07406	.7461	1.0258	.08605	.8047	1.0264	.09557	.8458	1.0233
2400	.07933	.7377	1.0319	.09271	.8003	1.0288	.10319	.8430	1.0240
2200	.08603	.7333	1.0387	.10104	.7995	1.0314	.11255	.8429	1.0248
2000	.09475	.7343	1.0453	.11155	.8024	1.0319	.12429	.8461	1.0250
1800	.10624	.7410	1.0485	.12507	.8097	1.0322	.13902	.8518	1.0239
1600	.12190	.7557	1.0511	.14252	.8202	1.0284	.15784	.8596	1.0199
1400	.14280	.7747	1.0456	.16570	.8344	1.0235	.18268	.8706	1.0172
14.4	17.88	.9975	1.0000	19.27	.9981	1.0000	20.37	.9984	1.0000
	130° F.			160° F.			190° F.		
	v	Z	W	v	Z	W	v	Z	W
5000	0.06299	1.0174	1.0088	0.06714	1.0321	1.0086	0.07133	1.0459	1.0089
4750	.06505	.9982	1.0101	.06946	1.0143	1.0095	.07391	1.0295	1.0096
4500	.06733	.9789	1.0107	.07208	.9971	1.0104	.07681	1.0136	1.0104
4250	.06995	.9604	1.0116	.07507	.9808	1.0115	.08013	.9985	1.0111
4000	.07302	.9436	1.0134	.07851	.9655	1.0127	.08397	.9849	1.0122
3750	.07658	.9278	1.0149	.08251	.9513	1.0135	.08845	.9726	1.0132
3500	.08080	.9136	1.0161	.08724	.9388	1.0146	.09367	.9614	1.0139
3250	.08584	.9013	1.0176	.09289	.9281	1.0159	.09985	.9515	1.0142
3000	.09197	.8914	1.0190	.09968	.9194	1.0163	.10727	.9437	1.0146
2800	.09789	.8855	1.0201	.10617	.9139	1.0166	.11434	.9388	1.0147
2600	.10487	.8809	1.0199	.11391	.9105	1.0173	.12269	.9354	1.0152
2400	.11333	.8787	1.0199	.12313	.9085	1.0175	.13257	.9330	1.0153
2200	.12367	.8790	1.0202	.13420	.9077	1.0170	.14442	.9317	1.0147
2000	.13635	.8810	1.0195	.14777	.9086	1.0160	.15887	.9317	1.0140
1800	.15220	.8851	1.0177	.16468	.9113	1.0147	.17682	.9333	1.0132
1600	.17242	.8913	1.0157	.18616	.9157	1.0134	.19954	.9362	1.0117
1400	.19885	.8994	1.0134	.21411	.9215	1.0109	.2290	.9401	1.0094
14.4	21.47	.9988	1.0000	22.57	.9990	1.0000	23.67	.9993	1.0000
	220° F.			250° F.			280° F.		
	v	Z	W	v	Z	W	v	Z	W
5000	0.07550	1.0581	1.0093	0.07956	1.0679	1.0092	0.08351	1.0754	1.0071
4750	.07834	1.0430	1.0098	.08266	1.0540	1.0095	.08682	1.0621	1.0071
4500	.08155	1.0285	1.0106	.08614	1.0406	1.0103	.90055	1.0494	1.0075
4250	.08519	1.0147	1.0111	.09009	1.0278	1.0107	.09479	1.0375	1.0079
4000	.08938	1.0021	1.0116	.09464	1.0162	1.0112	.09968	1.0269	1.0088
3750	.09424	.9905	1.0121	.09989	1.0055	1.0115	.10528	1.0168	1.0092
3500	.09990	.9800	1.0123	.10598	.9957	1.0113	.11180	1.0078	1.0096
3250	.10659	.9710	1.0125	.11317	.9873	1.0113	.11942	.9996	1.0094
3000	.11459	.9636	1.0129	.12172	.9802	1.0113	.12849	.9928	1.0096
2800	.12218	.9589	1.0134	.12977	.9754	1.0114	.13699	.9879	1.0092
2600	.13107	.9552	1.0131	.13919	.9714	1.0111	.14691	.9837	1.0092
2400	.14156	.9522	1.0125	.15029	.9683	1.0107	.15861	.9804	1.0093
2200	.15412	.9504	1.0117	.16356	.9659	1.0102	.17257	.9778	1.0090
2000	.16942	.9497	1.0115	.17969	.9647	1.0098	.18949	.9761	1.0087
1800	.18834	.9502	1.0108	.19958	.9644	1.0091	.2103	.9749	1.0079
1600	.2122	.9516	1.0092	.22462	.9647	1.0076	.....	.....	.....
1400	.....	.....	.....	.....	.....	.....	.....	.....	.....
14.4	24.76	.9994	1.0000	25.86	.9996	1.0000	26.96	.9997	1.0000

Note: Value of gas constant for 1.0 pound of gas is—

$$b = \frac{Pv}{ZT} = 0.52498 \frac{\text{lb. per sq. in. abs. x cu. ft. per lb.}}{\text{°F. abs.}}$$

Confirmation of Measurements

The steel pycnometer assembly was used for measuring the compressibility of most of the nitrogen and natural-gas mixtures, but points on the curve in Figure 13 also are shown for the data obtained when the two nitrogen and natural-gas mixtures were transferred from the equilibrium cell to the 12-liter flask. Thus, the data obtained and used to locate the smooth curve of Figure 13 confirmed the measurements made by means of the cell to determine the values of gas constants b for the mixtures containing 7.907 and 18.280 mole percent nitrogen.

The manner of mixing the samples of nitrogen and natural gas in the pycnometer was, in principle, the same as that used in mixing the samples for the measurements made by menas of the equilibrium cell. The separator gas was introduced into the pycnometer assembly under a pressure such that the quantity of gas contained in the pycnometer 1 (Figure 4) was the amount required for the desired mixture. Valve 2 then was closed and a vacuum pump connected at valve 4 was used to remove the gas from the other parts of the assembly including fixed electrode cell 5 and gas compressor 10. After valve 4 was closed, valve 2 was opened, and the measured quantity of separator gas was allowed to distribute itself throughout the pycnometer assembly.

Measuring Quantity of Nitrogen

The quantity of nitrogen required for mixture with the gas in the pycnometer assembly was measured under pressure in a separate calibrated vessel and then displaced by mercury from the vessel into the pycnometer assembly. The introduced nitrogen probably diffused uniformly throughout the gas in the pycnometer assembly; but, to make sure that the mixing of the two gases was complete, the volume of the mixture was changed several times by means of mercury pumped into and withdrawn from gas compressor 10. The next step, before expanding the mixture into the 12-liter

glass flask, was to adjust the pressure on the mixture in the pycnometer to 1400 psia, with the temperature maintained constant at 130° F., following the procedure already described.

Results

The data illustrated in Figure 13 indicate that, under the pressure and temperature conditions of the test, the compressibility of nitrogen and natural-gas mixtures departs from additive behavior by the maximum amount at a molal concentration of 45 percent nitrogen, where the value of the additive volume correction factor is 1.0205. If the data had been obtained at the same temperature (130° F.) and at approximately 2400 psia, the maximum value of the factor W, for a variable nitrogen concentration probably would have been greater than 1.0205. Also, the maximum value of the factor would have been greater if the pressure had been held at 1400 psia and the temperature of the tests had been 32° F. At 32° F. and 1600 psia, the maximum value of the additive volume correction factor W probably would exceed 1.07, representing a deviation of 7 volume percent from the volume that would be expected by additive mixing. This value for the factor is, of course, based on nitrogen concentrations much higher than those usually found in natural gas and is about the greatest deviation that would be found in gas transmission practice. For 1600 psia and 32° F., an additive volume correction factor of 1.0164 would be used far a gas containing 5 mole percent nitrogen.

Compressibility of Pure Nitrogen

The compressibility of pure nitrogen must be known, to estimate the compressibility of a natural gas containing nitrogen. The P-V-T characteristics of pure nitrogen have been determined by a number of investigators using different methods for preparing the gas and different equipment for measuring pressures, volumes, and temperatures. The published data on the compressibility of pure nitrogen have been averaged to compile the compressibility factors shown in Figure 14 and Table 5. Although the experimental temperatures commonly used by the investigators included 32°, 68°, 122°, 212°, 302°, and 572° F., the data presented in this report were computed by a process of graphical interpolation for temperatures in 30° F. intervals which do not include the experimental temperatures.

Many data on the compressibility of pure nitrogen were available in the low-pressure range. The data of Holborn and Otto[6] were obtained in the temperature range 32° to 572° F. and at pressures up to 1200 psi; the data of Onnes and Van Urk[6] were for 32° and 68° F. at pressures in the range of 500 to 1000 psi; and the data of Michels, Wouters, and De Boer[7] were in the temperature range 32° to 302° F. at 300 to 1200 psi. The data of Verschoyle[8] covered the pressure range up to 3000 psi at 32° and 68° F.

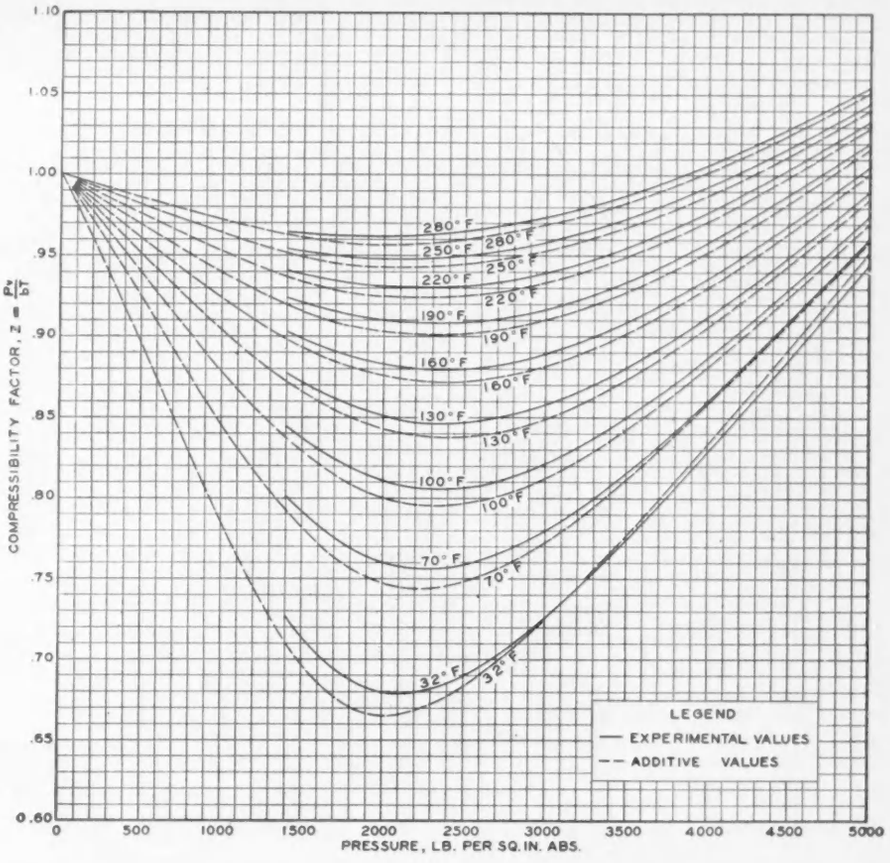

FIGURE 10. Compressibility factors for mixture containing 7.907 mole percent added nitrogen.

At pressures up to 5000 psi, in the temperature range 32° to 572° F., the data of Bartlett[9] and Bartlett, Cupples and Tremearne[10] were used. Also available were the data of Otto, Michels and Wouters[11] for temperatures in the range 32° to 302° F. at pressures up to 6000 psi. The data of Deming and Schupe[12] for temperatures in the range 32° to 572° F. and pressures in the range of 300 to 18,000 psi were particularly useful for evaluating compressibility factors in the 5000 to 7000 psi pressure range.

The average of the data used for evaluating compressibility factors at pressures below 1000 psi indicate an accuracy uncertainty of 0.03 percent. In the 1000 to 5000 psi pressure range the accuracy uncertainty of the averages is approximately 0.16 percent. Data computed for pressures above 5000 psi have high accuracy, but information was not available from enough sources to permit an estimate of the accuracy uncertainty of the values of reported compressibility factors at pressures greater than 5000 psi.

Computing the Compressibility of a Natural Gas Containing Nitrogen

Three methods are in common use for determining the compressibility of a natural gas. The direct and most reliable method is to measure the compressibility using a device like the pycnometer assembly described in this report or some type of equilibrium cell.[8,13,14,15] Knowledge of the composition of the gas is not required, and the accuracy of the result is not affected by the nitrogen, carbon dioxide, or other nonhydrocarbon components of the natural gas in abnormal concentrations. The determination can be made in a few hours by means of simple

SORRY!

Through an engraver's error both charts which appeared on pages 206 and 207 of the May issue with the article "Estimating Gathering System Meter Run Sizes" by J. B. Arant were published without the title of the abscissae appearing on the plate. In both curves, the abscissae should be titled "Quantity—MSCFD."

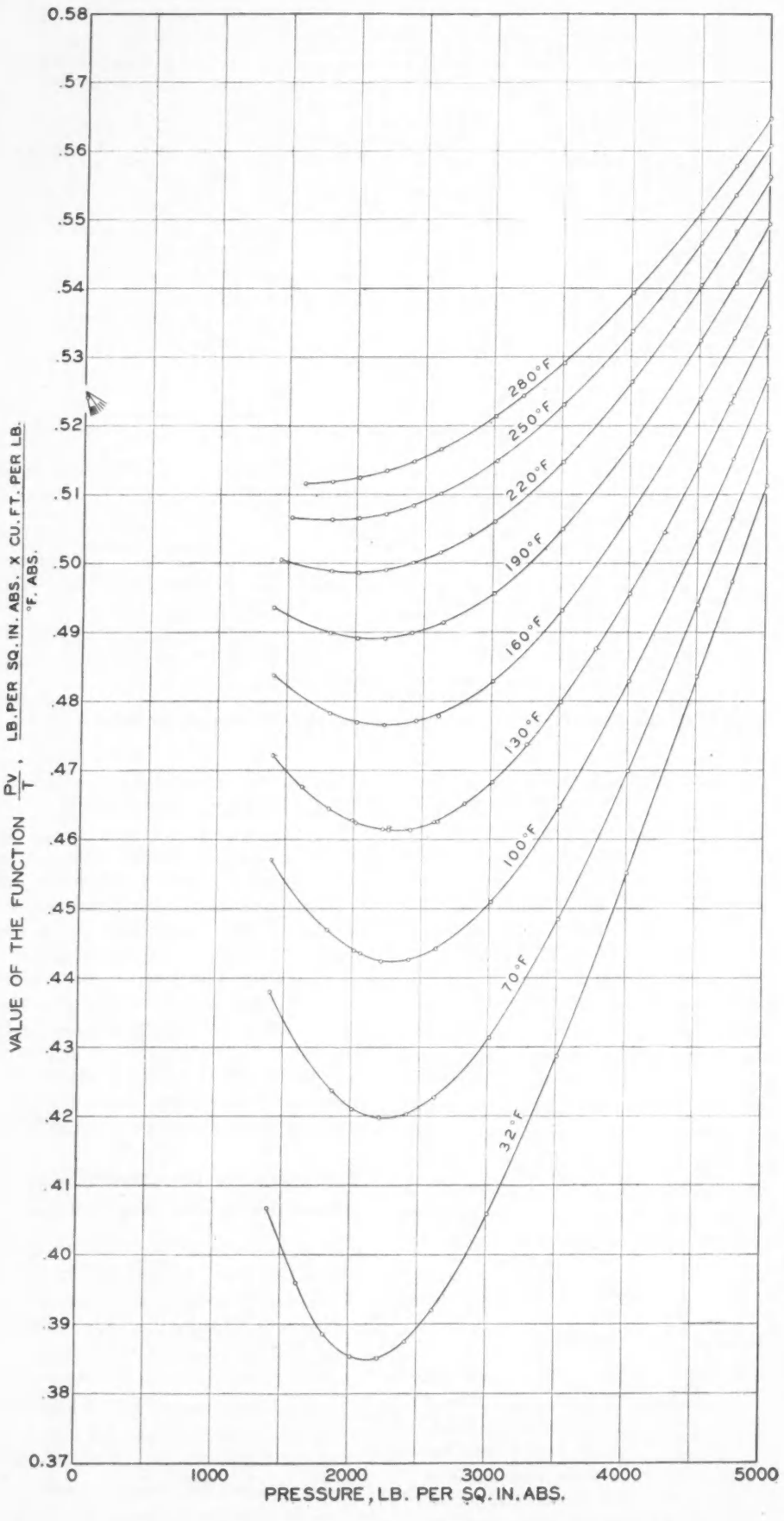

FIGURE 11. Specific volume data for mixture containing 18.280 mole percent added nitrogen.

apparatus if the sample remains in a gas phase during the entire test. Apparatus which provides for stirring of the gas and liquid phases will be required if a condensate forms in any stage of the determination.

The method involving the least expenditure of time is the one requiring a knowledge of only some simple property of the gas, such as its specific gravity referred to dry air. This method can be used when the gas is of average composition and high accuracy is not required. For example, Standing and Katz[16] (Figures 3, 4 and 5) have published charts in which the density and the pseudocritical properties of natural gases are related to gas gravity. Using these charts, the compressibility of a gas for a given temperature and pressure can be estimated if the gravity is known. Unpublished charts in the files of the Bureau of Mines at Bartlesville, Okla., have been used in field work for computing orifice coefficients required in measuring the flow of gas under pressure. The charts show the compressibility of the gas as a function of the gas gravity which is measured by means of a gas gravity balance. For the method to provide satisfactory solutions, it must be applied only to gases that do not contain abnormally high concentrations of carbon dioxide, nitrogen, or heavy hydrocarbon components. Errors exceeding 3 percent may result if the method is applied to gases under pressures greater than 3000 psi or to fluids containing a condensate at the temperatures and pressures of interest.

Computation Method

The most widely used method for determining the compressibility of a natural gas is one of computation and requires knowledge of the composition of the gas, as usually is obtained by low-temperature fractional distillation. The volume or the compressibility of the gas is calculated by means of some concept of the volume or compressibility of the components in the gas. Frequently, the composition of the gas has been determined for other purposes, and the effort involved in determining the compressibility is only the effort of the computations. The difference in the values of the compressibility of a gas determined experimentally and by this method usually is less than 1 percent, but differences as great as 2 or 3 percent are possible at high pressures or low temperatures. The investigations, described in this report, of the effect of added nitrogen on the compressibility of a natural gas, were made to supplement this commonly used method.

Sage and Lacey[17] have demonstrated a means of computing the volume of gas mixtures from the partial volumes of the

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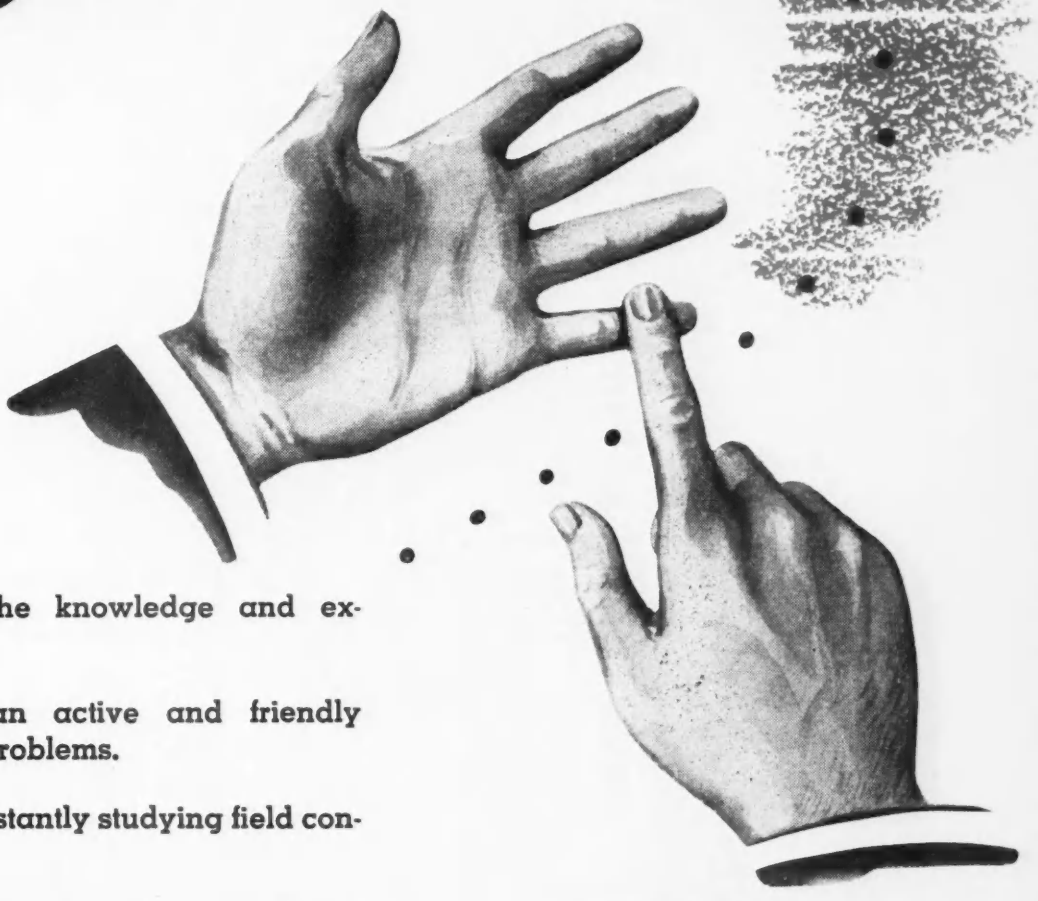

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components in the mixture. The volume of a component of the mixture at a given pressure and temperature usually will not be the same as the volume of the pure component in an isolated state at the same pressure and temperature. The natures of other components in a mixture and their concentrations determine to an appreciable extent the volume of a unit weight of the given component. The basic data required for computing the volume of a gas mixture are the partial specific volumes of each of the components in the particular mixture at the given pressure and temperature and the composition of the mixture on a mass fraction basis.

Kay[18] proposed utilizing "the theorem of corresponding states" for calculating the PVT relations of hydrocarbon mixtures and showed how a "pseudocritical" pressure and temperature for a given mixture could be calculated which would permit an estimation of the properties of the mixture in a given state from the known properties of pure components in the corresponding state. Smith[19] (Figure 2) published a chart based primarily on the properties of methane which was designed for computing the compressibility of natural gas at pressures up to 4000 psi. The chart showed the compressibility factors as a function of reduced pressures and temperatures—the reduced pressures and temperatures identifying the corresponding states. Brown and Holcomb[20] (Figure 4) published a similar chart prepared for use at pressures up to 5000 psi and based on the properties of natural gases and binary mixtures containing methane. Standing and Katz[21] summarized the information available on the use of reduced pressure and temperature diagrams for computing the compressibility of gases and included a chart based on the compressibility of methane which extended the pressure range of application to approximately 9000 psi; data on natural gas at temperatures ranging from —116° to 400° F. were provided.

TABLE 5

Compressibility Factors for Nitrogen

Pressure Lbs. per Sq. In. Absolute	COMPRESSIBILITY FACTORS (Z) AT INDICATED TEMPERATURE						
	32° F.	40° F.	70° F.	100° F.	130° F.	160° F.	190° F.
7000	1.3540	1.3522	1.3447	1.3380	1.3321	1.3270	1.3220
6500	1.3095	1.3081	1.3039	1.3001	1.2970	1.2940	1.2912
6000	1.2659	1.2653	1.2642	1.2634	1.2627	1.2619	1.2607
5500	1.2230	1.2233	1.2251	1.2268	1.2280	1.2288	1.2291
5000	1.1802	1.1815	1.1864	1.1904	1.1938	1.1963	1.1980
4750	1.1597	1.1615	1.1678	1.1731	1.1772	1.1806	1.1832
4500	1.1400	1.1423	1.1500	1.1564	1.1614	1.1654	1.1685
4250	1.1206	1.1233	1.1326	1.1400	1.1459	1.1505	1.1541
4000	1.1023	1.1057	1.1163	1.1248	1.1312	1.1363	1.1402
3750	1.0847	1.0882	1.1003	1.1097	1.1169	1.1225	1.1269
3500	1.0680	1.0722	1.0854	1.0957	1.1035	1.1095	1.1144
3250	1.0524	1.0568	1.0713	1.0823	1.0906	1.0968	1.1020
3000	1.0383	1.0432	1.0580	1.0700	1.0789	1.0855	1.0903
2800	1.0277	1.0325	1.0481	1.0603	1.0693	1.0760	1.0812
2600	1.0185	1.0233	1.0387	1.0513	1.0602	1.0672	1.0724
2400	1.0100	1.0150	1.0302	1.0428	1.0517	1.0594	1.0639
2200	1.0025	1.0068	1.0223	1.0344	1.0431	1.0502	1.0557
2000	.9955	1.0000	1.0150	1.0271	1.0360	1.0429	1.0484
1800	.9904	.9948	1.0092	1.0209	1.0293	1.0361	1.0413
1600	.9860	.9900	1.0040	1.0149	1.0230	1.0294	1.0345
1400	9837	.9874	1.0001	1.0100	1.0177	1.0236	1.0283
1200	.9824	.9860	.9973	1.0061	1.0129	1.0183	1.0226
1000	.9823	.9853	.9956	1.0033	1.0093	1.0138	1.0178
900	.9828	.9859	.9950	1.0021	1.0077	1.0119	1.0154
800	.9835	.9861	.9947	1.0010	1.0061	1.0100	1.0130
700	.9846	.9869	.9942	1.0001	1.0048	1.0083	1.0111
600	.9861	.9879	.9945	.9997	1.0037	1.0066	1.0090
500	.9878	.9895	.9950	.9994	1.0026	1.0050	1.0071
400	.9897	.9911	.9956	.9991	1.0018	1.0038	1.0056
300	.9920	.9930	.9964	.9990	1.0010	1.0026	1.0039
200	.9945	.9953	.9976	.9992	1.0005	1.0015	1.0023
100	.9971	.9975	.9986	.9995	1.0002	1.0007	1.0011
14.4	.99955	.99960	.99977	.99991	1.00001	1.00009	1.00016

	220° F.	250° F.	280° F.	310° F.	340° F.	370° F.	400° F.
7000	1.3173	1.3129	1.3082	1.3036	1.2989	1.2942	1.2893
6500	1.2882	1.2851	1.2819	1.2780	1.2741	1.2700	1.2660
6000	1.2589	1.2570	1.2548	1.2520	1.2490	1.2458	1.2422
5500	1.2291	1.2283	1.2271	1.2255	1.2237	1.2212	1.2187
5000	1.1990	1.1995	1.1992	1.1985	1.1974	1.1959	1.1942
4750	1.1849	1.1860	1.1864	1.1858	1.1851	1.1838	1.1823
4500	1.1708	1.1723	1.1730	1.1731	1.1727	1.1718	1.1706
4250	1.1568	1.1588	1.1600	1.1605	1.1604	1.1598	1.1589
4000	1.1437	1.1460	1.1476	1.1485	1.1489	1.1488	1.1482
3750	1.1305	1.1332	1.1351	1.1365	1.1372	1.1374	1.1371
3500	1.1181	1.1211	1.1234	1.1248	1.1258	1.1263	1.1263
3250	1.1060	1.1091	1.1117	1.1135	1.1147	1.1153	1.1155
3000	1.0948	1.0982	1.1009	1.1027	1.1039	1.1047	1.1050
2800	1.0857	1.0892	1.0920	1.0941	1.0953	1.0962	1.0965
2600	1.0772	1.0806	1.0834	1.0855	1.0868	1.0877	1.0883
2400	1.0683	1.0721	1.0748	1.0770	1.0785	1.0795	1.0802
2200	1.0606	1.0642	1.0669	1.0692	1.0708	1.0719	1.0725
2000	1.0528	1.0561	1.0588	1.0611	1.0630	1.0640	1.0650
1800	1.0454	1.0485	1.0511	1.0532	1.0549	1.0564	1.0571
1600	1.0385	1.0417	1.0442	1.0463	1.0478	1.0490	1.0500
1400	1.0321	1.0352	1.0375	1.0394	1.0408	1.0419	1.0428
1200	1.0261	1.0291	1.0314	1.0330	1.0343	1.0355	1.0362
1000	1.0209	1.0235	1.0253	1.0267	1.0279	1.0288	1.0294
900	1.0182	1.0204	1.0223	1.0236	1.0248	1.0256	1.0263
800	1.0156	1.0178	1.0193	1.0207	1.0218	1.0226	1.0232
700	1.0133	1.0151	1.0167	1.0178	1.0188	1.0195	1.0201
600	1.0110	1.0127	1.0140	1.0150	1.0161	1.0167	1.0172
500	1.0088	1.0102	1.0116	1.0123	1.0132	1.0138	1.2142
400	1.0070	1.0081	1.0091	1.0098	1.0106	1.0110	1.0114
300	1.0050	1.0059	1.0066	1.0072	1.0078	1.0081	1.0084
200	1.0031	1.0038	1.0044	1.0048	1.0054	1.0055	1.0058
100	1.0015	1.0018	1.0021	1.0024	1.0027	1.0028	1.0030
14.4	1.00021	1.00025	1.00030	1.00034	1.00037	1.00039	1.00039

Note: Value of the gas constant for 1.0 pound of gas is—

$$b = \frac{Pv}{ZT} = 0.38304 \frac{\text{lb. per sq. in. abs. x cu. ft. per lb.}}{\text{°F. abs.}}$$

The compressibility of a nitrogen and natural-gas mixture at a given pressure and temperature also may be computed by means of a modified form of equation 7 and equation 11 as follows:

$$Z_a = \underline{n}\, Z_n + (1 - \underline{n})\, Z_h \quad \ldots\ldots 12$$

where,

Z_n = compressibility of the nitrogen in the gas sample, read from Figure 6 or Table 5.

Z_h = compressibility of the mixture of hydrocarbons in the gas sample,

$\underline{n}$ = mole fraction (volume fraction of the gas, which is nitrogen.

The computed value of the additive compressibility factor Z_a then must be corrected to the actual value Z, the compressibility factor for the mixture, by means of equation 11,

$$Z = W\, Z_a$$

The value of the factor Z_h for the mixture of hydrocarbons in the sample can be computed using any one of the methods that have been discussed. For the purpose of illustrating the computation and the use of equation 12, the values of the critical constants and a chart of compressibility factors given in the Technical Manual (21, pp. 48-52) of the Natural Gasoline Supply Men's Association (see also reference 20) have been used in solving a compressibility problem. The steps of the solution are compiled in Table 6.

Composition of a Natural Gas

Column 2 of Table 6 shows the composition of a natural gas containing 10 percent nitrogen. The nitrogen content has been assumed, for the purpose of illustration, but the proportions of the hydrocarbons are identical with the proportions of the hydrocarbons in a gas sample from a separator at a gas-condensate well. The first step is to compute the compressibility of the hydrocarbon part of the gas, that is, the compressibility of the nitrogen-free gas. The hydrocarbon part of the gas sample (column 2) is 0.90000 of the entire sample. The mole fractions n in column 3 were obtained by dividing the mole frac-

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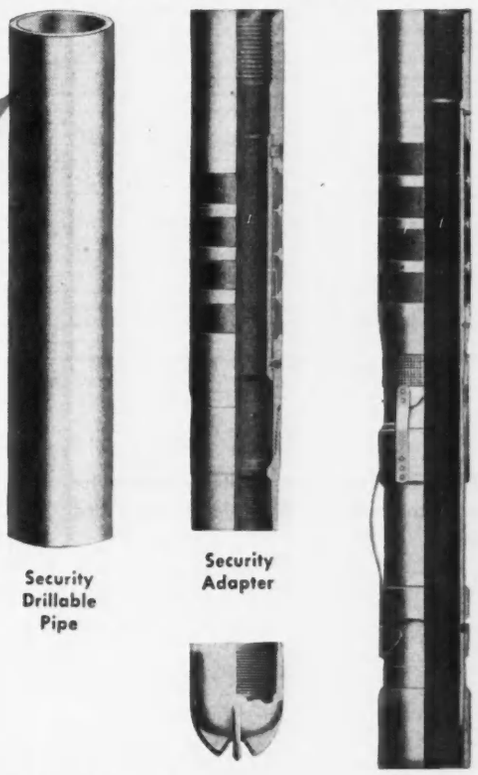

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tions in column 2 by 0.9, omitting the quotient for nitrogen. Thereafter the computations of the columnar data are according to the directions given in the manual.[21] The products of the mole fractions in column 3 and the corresponding critical temperatures of the components listed in column 4 are added in column 5. The summation of the products, 368.10° F. abs., is the value of the pseudocritical temperature of the nitrogen-free gas (column 3). The critical pressures of the components are given in column 6, and in column 7 are the mole fraction-critical pressure products, the sum of which, 670.87 psia, is the pseudocritical pressure.

The compressibility factor of the nitrogen-free gas was computed for 160° F. (620° F. abs.) and 3000 psia. The pseudo reduced temperature and pressure were calculated as indicated in Table 6, and the respective values 1.684 and 4.472 were used to determine from Figure 3 of the manual the compressibility factor $Z_h = 0.853$ for the hydrocarbon part of the gas sample shown in column 2. Figure 3 of the manual is a plot of compressibility factors as a function of pseudo reduced pressures and temperatures based on the volumes of certain natural gases and binary mixtures containing more than 50 percent methane. Any other plot or any other method could have been used in estimating the compressibility factor for the hydrocarbon part of the gas sample.

The compressibility factor for nitrogen (Z_n=1.0855) at 160° F. and 3000 psia was obtained from Table 5. Figure 14 also could have been used if an interpolation of the tabulated compressibility values had been necessary.

The values for the compressibility of the hydrocarbon part (0.9 mole fraction) of the gas sample and the nitrogen part (0.1 mole fraction) of the gas sample were used to solve equation 12, from which the value of 0.876 was obtained for the additive compressibility factor. This value for the compressibility of the nitrogen and natural-gas mixture is based on an assumption that the sum of the volumes of the nitrogen and the hydrocarbons measured separately under pressure will remain unchanged if the gases are mixed. Actually the volumes would increase slightly on mixing, and correction for such increase in volume was made by using the additive volume correction factor, $W = 1.0104$. The product, $WZ_a = 0.885$, is the value of the compressibility factor for the nitrogen and natural-gas mixture.

Values of the additive volume correction factor W are shown in Tables 3 and 4 for the mixtures used in this investigation. These mixtures contained 7.907 and 18.280 mole percent nitrogen. The experimentally determined values for the correction factor have been used in preparing Figure 15, which shows values of the factor W as a function of temperature, pressure, and mole percent of added nitrogen. Values of the factor for the temperature range 32° to 280° F. up to 5000 psi and for nitrogen concentrations up to 20 mole percent can be obtained by processes of interpolation

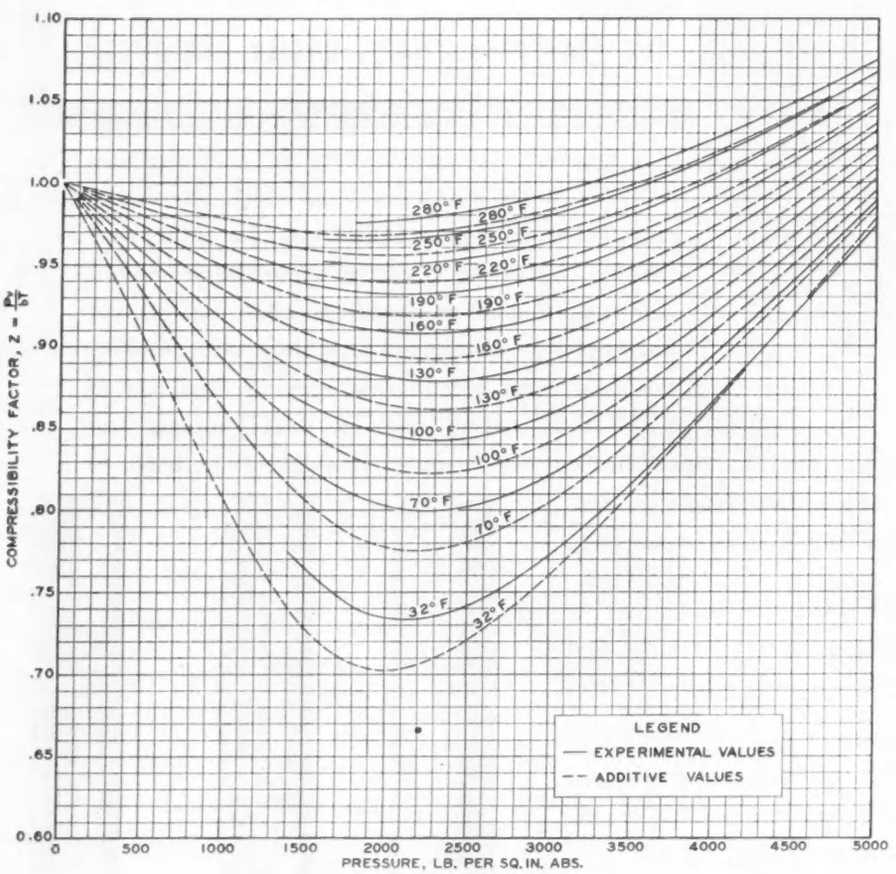

FIGURE 12 (Top). Compressibility factors for mixture containing 18.280 mole percent added nitrogen.

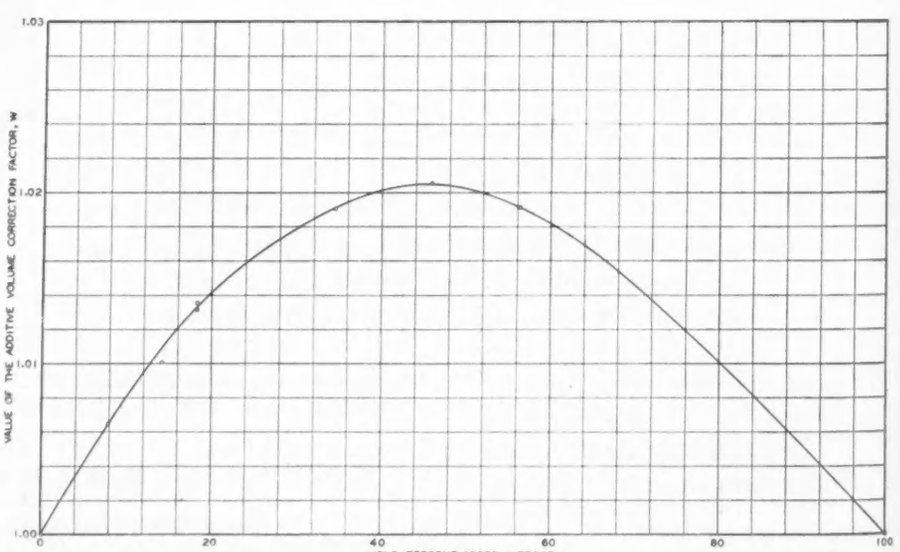

FIGURE 13 (Bottom). Value of the additive volume correction factor, W at 130° F. and 1400 lb. per sq. in. abs.

and extrapolation. Figure 13, previously discussed, shows experimentally determined values of the factor W at 1400 psia and 130° F. for nitrogen concentrations up to 56 mole percent.

The data illustrated in Figure 15 show that the values of factor W increase as the temperature decreases. Except at the lowest temperature of the tests (32° F.), where values of the factor W are less than unity, the volumes of mixtures of nitrogen and natural gas are greater than those of the separate constituents. In applying these factors to calculation of the compressibility of nitrogen and natural-gas mixtures, it must be assumed that the values found for the factors in experimentation with natural gas of the composition given in Table 1 apply also to other gases, provided that they are not abnormal in composition. The natural gas used in this investigation was selected because it was average as to composition. It is believed that the data obtained for correcting additive volume compressibility can be applied to problems involving the production and transmission of average natural gases with greater accuracy than is probable in computing the compressibility of the hydrocarbons in the gases.

It is of interest to consider the relation between the results obtained when the method illustrated in Table 6 is used to compute the compressibility of a nitrogen and natural-hydrocarbon mixture and when an estimate of the compressibility of the mixture is made assuming that nitrogen has the same compressibility as the hydrocarbons at corresponding states. Two mixtures, each containing hydrocarbon components in the proportions shown in column 3 of Table 6, together with nitrogen in a molal concentration of 10 percent in one mixture and 20 percent in the other, were treated mathematically for comparison. The results of the computations are presented in Table 7.

The gas mixture containing 10 percent nitrogen had the composition given in column 2 of Table 6. A critical pressure of 492 psia and a critical temperature of 227° F. abs, were used in calculating the effect of the nitrogen on the pseudocritical pressure and temperature of the mixture of nitrogen and natural hydrocarbons. Product nP_c and nT_c were computed for nitrogen just as they were computed for the hydrocarbon components in the solution of the problem illustrated in Table 6. Reduced pressures and temperatures corresponding to the pressures and temperatures listed in Table 7 were calculated for selecting compressibility factors directly from the chart of corresponding state properties (21, Figure 3). For example at 3000 psia and 160° F. the pseudocritical pressure was 653.0 psia, the pseudocritical temperature was 354.0° F. abs., and the compressibility factor taken from the chart is 0.878.

Table 6 shows that the solution provided by use of the additive volume correction factor is $WZ_a = 0.885$. The difference in the results obtained by means of the two solutions, $0.885 - 0.878 = 0.007$, when expressed as percent of difference provided the datum 0.8 shown in Table 7 for the mixture containing 10 percent nitrogen at 3000 psia and 160° F. Positive values of the figures in Table 7 indicate that the computed compressibility of a natural-gas mixture containing nitrogen will be low by the indicated percentage, if the computation involves assumption that nitrogen has the same compressibility as the hydrocarbons in corresponding states.

Uncertainty in the value of the compressibility factor of nitrogen and natural-hydrocarbon mixtures introduced by the assumption that nitrogen and the hydrocarbons have identical compressibilities in corresponding states appears to be less than 1 percent if the nitrogen content of the mixture is less than 10 percent. The magnitude of the uncertainty increases with nitrogen concentration, and if the gas contains 20 percent nitrogen, the error in the computation of the compressibility factor may be two to three percent.

Compressibility of Carbon Dioxide in Natural Gas

Carbon dioxide is a common component of natural gases and should be

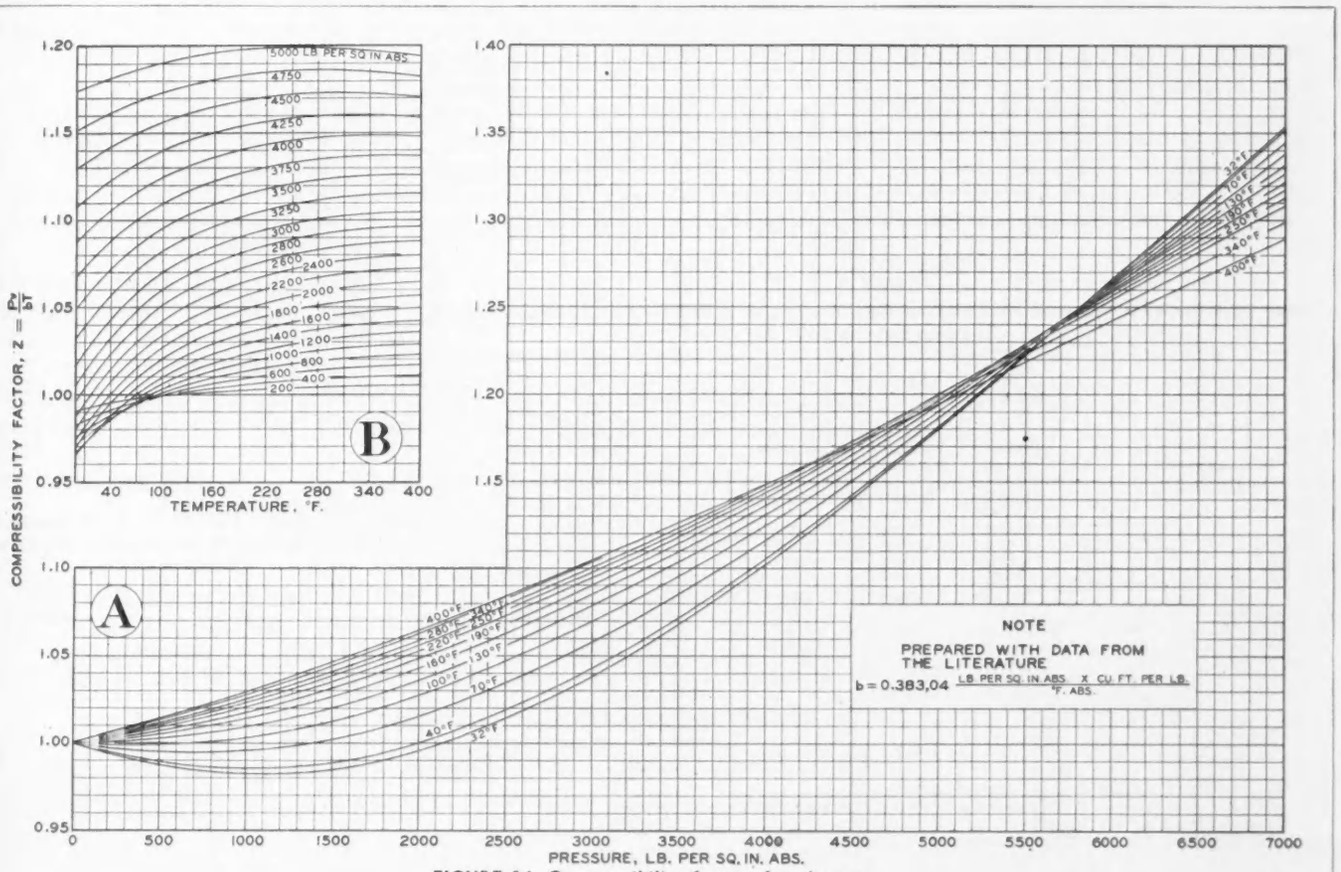
COMPRESSIBILITY FACTOR, Z = PV/nRT
TEMPERATURE, °F.
PRESSURE, LB. PER SQ. IN. ABS.
15000 LB PER SQ IN ABS
B
A
NOTE
PREPARED WITH DATA FROM THE LITERATURE
b = 0.383,04 LB PER SQ IN ABS X CU FT PER LB. °F. ABS.

FIGURE 14. Compressibility factors for nitrogen.

considered in calculating compressibility factors. Olds, Sage and Lacey[23] investigated the partial volumetric behavior of carbon dioxide in methane, and Reamer, Olds, Sage, and Lacey[25] determined the compressibility factors for mixtures of carbon dioxide and ethane. These data provide information for estimating the effect of contained carbon dioxide on the compressibility of a natural gas.

The compressibility factors for pure carbon dioxide at its critical and higher temperatures are approximately equal to the compressibility factors for methane and other hydrocarbons at the same reduced pressures and temperatures. For natural gases containing 2 percent or less of carbon dioxide, application of the theorem of corresponding states to carbon dioxide permits calculating reliable compressibility factors. With reference to Table 6, the pseudocritical pressure and temperature of a hydrocarbon mixture containing carbon dioxide may be computed using 1073 psia and 548° F. abs. as the critical pressure and temperature, respectively, of carbon dioxide. In computing the compressibility of a gas containing carbon dioxide in addition to nitrogen, one should proceed with all the steps indicated in Table 6, treating the carbon dioxide component in the same manner as the hydrocarbons are treated.

Summary

Nitrogen was mixed with a natural gas in different proportions to determine the effect of the nitrogen on the compressibility of the resultant mixtures. At experimental temperatures above 32° F., the volumes of the mixtures were as much as 3 percent greater than the volumes of the separate constituent gases at given pressures and temperatures. The natural gas had a specific gravity of 0.649, referred to dry air, and contained 88 percent of methane and less than 0.6 percent of pentanes and heavier components. The results obtained in experimenting with this gas and admixtures of nitrogen are believed to be applicable for computing accurately the compressibilities of other natural gases containing nitrogen.

The specific volume data were obtained by means of an equilibrium cell at pressures up to 5000 psi over the temperature range 32° to 280° F. The baro-buret was used for accurate measurements of volume at subatmospheric pressures and a steel pycnometer assembly was developed and used for determining single compressibility factors of the gas mixtures.

The investigation was planned to provide information for estimating the compressibility of nitrogen and natural-hydrocarbon mixtures on the basis of the compressibility of the two constituents. Data on the P-V-T relationships of pure nitrogen were compiled from the literature to provide compressibility factors for pressures up to 7000 psi over a temperature range of 32° to 400° F. The compressibility of the natural gas was determined by direct measurements. Knowing the compressibility of the two constituents of the mixtures, the volumes of the experimental mixtures were calculated by assuming that the volume of the mixture will be equal to the sum of the volumes of the separate constituents when nitrogen and natural gas at given pressures and temperatures are combined. The volumes of the mixtures also were measured experimentally, and it was found that the ratio of the volume determined experimentally to the additive or calculated volume usually was greater than one. Values of this ratio, called additive volume correction factors, were determined for 32° to 280° F. up to 5000 psi. Natural-gas mixtures containing added nitrogen in concentrations of 7.9 and 18.3 mole percent were used in the investigations. Several mixtures containign up to 56 mole percent nitrogen were used in determining values of the correction factors at 1400 psia and 130° F.

Above 190° F. the additive volume correction factors ranged in value from 1.00 at zero concentration of nitrogen to approximately 1.01 for a nitrogen concentration of 20 mole percent. With decrease in temperature to 100° F., the values of the factor for a nitrogen concentration of 20 mole percent increased to approximately 1.02. A value of 1.05 for the factor at a nitrogen concentration of 20 mole percent was measured at the lowest experimental temperature, which was 32° F. In general, for nitrogen concentrations up to 45 percent, the value of the additive volume correction factor increased as the nitrogen concentration increased and as the temperature decreased.

An example is given to show the use of additive volume correction factors for calculating the compressibilities of a natural gas containing nitrogen. The various ways for computing the compressibility of the hydrocarbon part of the gas sample are reviewed in the report. Any one of these methods is satisfactory for use with the additive volume correction factors, provided it can be applied accurately to the analysis of the gas sample. The volumes or the compressibilities of the nitrogen and the hydrocarbon parts of the sample are calculated independently; and the results, combined on a mole fraction basis, provide a sum that is multiplied by the additive volume correction factor to obtain the actual volume or compressibility of the mixture.

The technique of determining the volumes of natural gases under high pressures has been considerably advanced in recent years, and this report on the compressibility of nitrogen and natural-gas mixtures is intended merely to sup-

TABLE 6

Compressibility of a Nitrogen and Natural-Gas Mixture at a Pressure of 3000 psia and a Temperature of 160° F.

1	2	3	4	5	6	7
Component	Mole Fraction	n, Mole Fraction (Nitrogen-Free Gas)	T_c, Critical Temperature of Component, °F. Abs.	nT_c	P_c, Critical Pressure of Component, psia.	nP_c
Nitrogen	0.10000	0.00000	.....	.....	.....	.....
Methane	.82394	.91549	344	314.93	673	616.12
Ethane	.04324	.04805	549	26.38	712	34.21
Propane	.01766	.01962	666	13.07	617	12.10
Isobutane	.00443	.00492	732	3.60	544	2.68
Normal butane	.00378	.00420	766	3.22	551	2.31
Isopentane	.00225	.00250	829	2.07	483	1.21
Normal pentane	.00090	.00100	846	.85	485	.48
Isohexanes	.00099	.00110	900	.99	451	.50
Normal hexane	.00065	.00072	914	.66	435	.31
Heptane plus	.00216	.00240	972	2.33	397	.95
	1.00000	1.00000	.....	368.10	.....	670.87

Pseudo reduced temperature $= \frac{620}{368.10} = 1.684$ Pseudo reduced pressure $= \frac{3,000}{670.87} = 4.472$

Compressibility of the mixture of hydrocarbon components, Z_h (Natural Gasoline Supply Men's Association Handbook, 1946, p. 52, fig. 3) ..... = 0.853

Compressibility of nitrogen, Z_n ..... = 1.0855

Compressibility of nitrogen and natural-gas mixture on an additive basis, $Z_a = \underline{n} Z_n + (1 - \underline{n}) Z_h$ ..... = .876

Additive volume correction factor, W ..... = 1.0104

Corrected compressibility factor, $Z = WZ_a$ ..... = .885

TABLE 7

Comparison of Two Methods of Calculating Effect of Nitrogen on Compressibility of a Natural Gas

Temp. °F.	Percent of Difference at Indicated Pressures (psia.) in Computed Values of Compressibility Factors			
	2,000	3,000	4,000	5,000
		10 Percent Nitrogen		
250	0.4	0.6	0.7	1.0
160	.7	.8	.9	.9
32	1.3	.1	.0	.4
		20 Percent Nitrogen		
250	2.1	2.7	2.7	2.8
160	1.1	1.2	1.7	2.0
32	2.4	1.9	2.1	2.2

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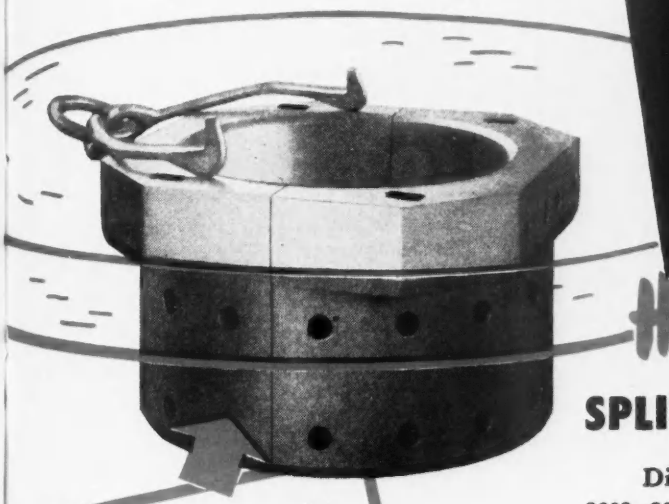
Why not run your casing with the same simplicity, speed and convenience as you do drill pipe?

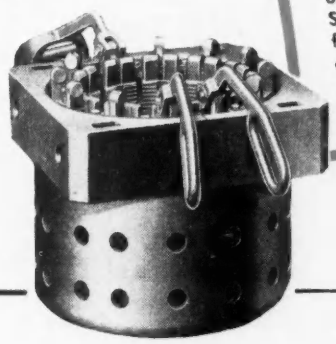


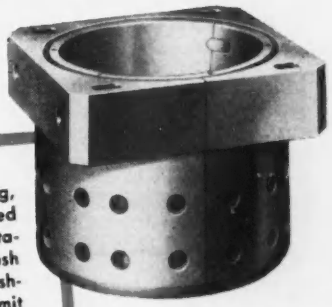
Here's how... with the BAASH-ROSS SPLIT ROTARY TABLE CASING BUSHING

Did you know that you can run casing jobs with the same ease, convenience and simplicity with which you run your drill pipe? All that you need is a Baash-Ross Split Rotary Table Casing Bushing which replaces the regular master bushings in the rotary table and permits casing to be run *through the table* with the crew working at the same convenient height and in the same efficient manner as when handling drill pipe. Here's all you do...

1 Simply lift out the regular master bushings, drop in the Split Casing Bushing and lock the table. The Split Casing Bushing is thus solidly supported and properly centered over the hole so that you can run casing with the same ease and with the crew working at the same convenient height as when running drill pipe.

2 For large diameter casing, the larger sizes of Baash-Ross Type "UC" Casing Slips can be seated directly in the bore of the Split Bushing. As outlined below, "UC" Casing Slips insure a uniform full-circumferential grip on the casing that eliminates risk of damaging the thin casing walls through concentration of slip pressure.





3 For smaller sizes of casing, drop in a split and hinged Slip Adapter which is tapered on both sides and sets flush with the top of the Casing Bushing. Removable handles permit quick and convenient insertion of the split and hinged Slip Adapter.

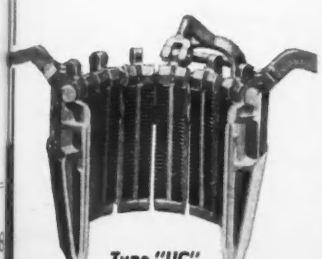
4 With the Slip Adapter in place, Baash-Ross Type "UC" Casing Slips to fit smaller sizes of casing can be set directly into the tapered bore of the Slip Adapter, thus permitting a wide range of casing jobs to be run with equal efficiency.

Handles Wide Range of Casing Sizes

Rotary Bore	Maximum Casing Size
27½" Dia.	21½" API
24½" Dia.	18⅝" API
20½" Dia.	16" API
17½" Dia.	13⅜" API

Modern rotary tables are able to support even the longest and heaviest casing strings with ample safety, and the Split Rotary Table Casing Bushing is ruggedly built to withstand the same service. Yet it is light in weight and readily portable in small tool cars.

The maximum casing size handled by the Casing Bushing is determined by the diameter of the opening through the rotary table. The accompanying chart shows the largest casing size that will pass through the Casing Bushings made for various size rotaries.



Type "UC" Casing Slips

Type "UC" Casing Slips Insure Maximum Safety in Modern Casing Operations

Baash-Ross "UC" Casing Slips are the most modern advancement in slips for handling casing strings. Because they consist of many narrow slip segments flexibly linked together, they *u-r-a-p* around the casing for a uniform, full-circumferential grip, thus insuring greater safety and maximum gripping efficiency on the relatively thin walls of casing strings. Their easily-renewable liners provide long life and low maintenance, and they have many other unique features. For more details see page 276 of the 1947 Composite Catalog.

Baash-Ross Split Casing Bushings are available domestically through leading supply stores.

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plement the technology where it is least advanced. The writers hope that the information given in this report will be helpful to the industry in solving its problems of reservoir engineering and transmission of natural gas.

ACKNOWLEDGEMENTS

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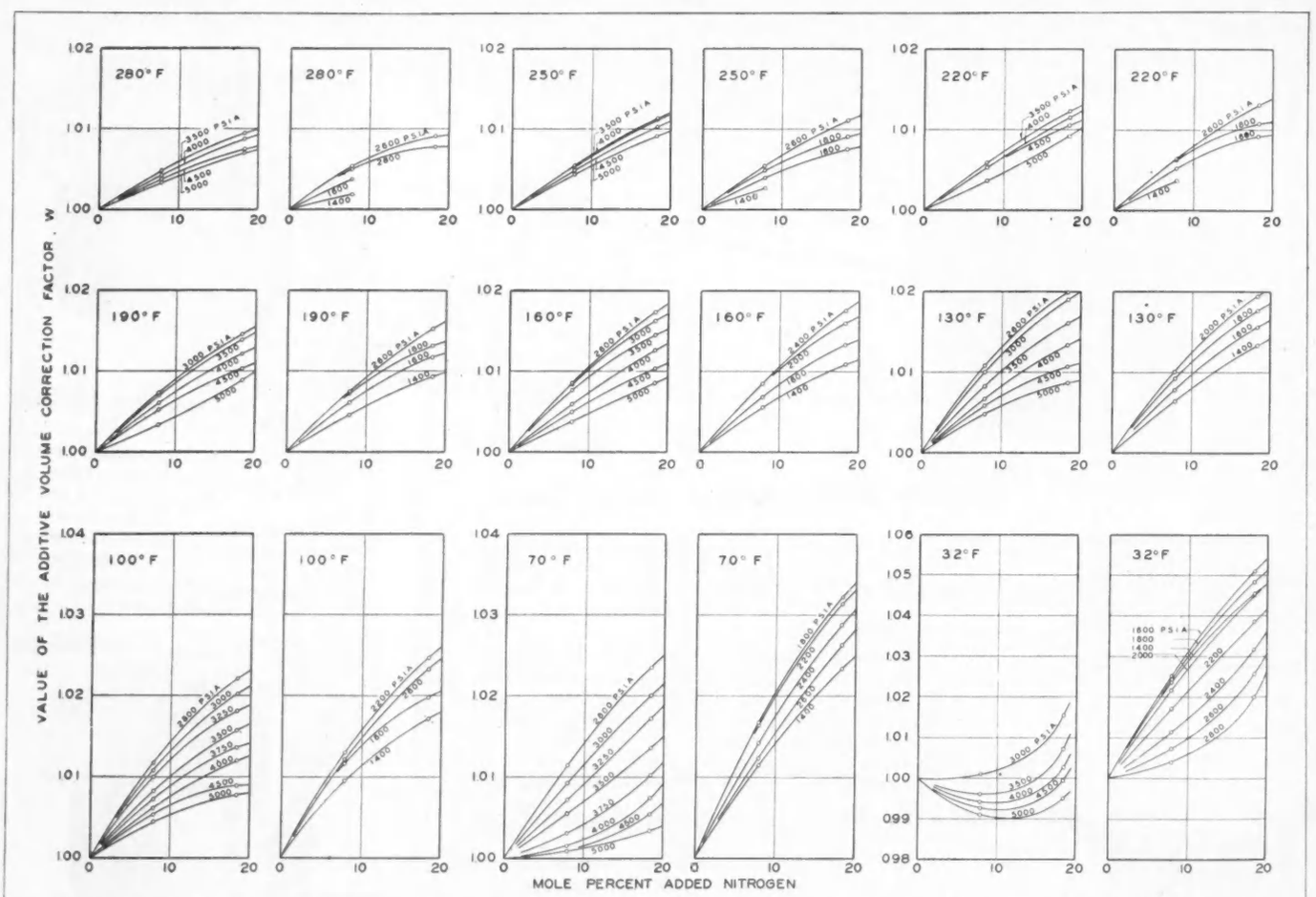
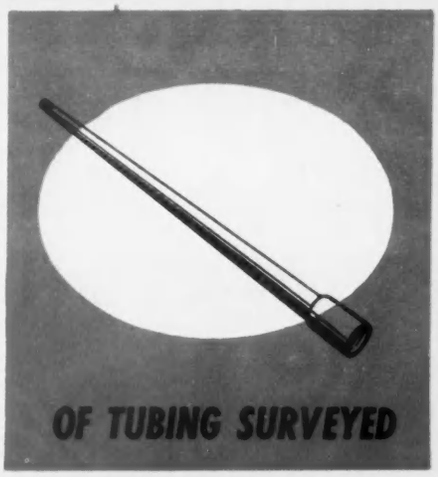
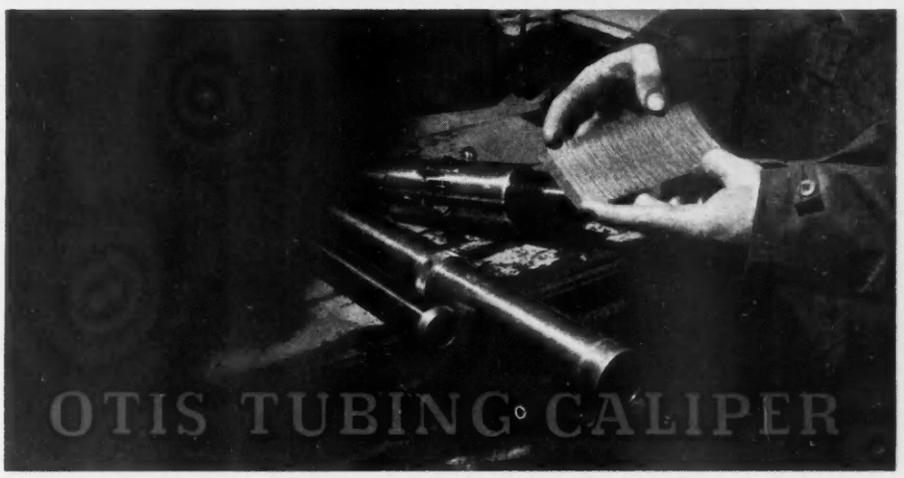


FIGURE 15. Value of the additive volume correction factor as a function of pressure, temperature, and concentration of added nitrogen.





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By PARK J. JONES

Condensate PRODUCTION AND CYCLING

Part 18

Water Injection Into a Stratigraphic Trap

A pressure maintenance program by water injection is mapped out for a stratigraphic type condensate reservoir. The optimum rate of condensate production is about 12 percent per year of in place condensate.

CONSIDER the reservoir mapped out in Figures 18-1 through 4. This is a stratigraphic type condensate reservoir. Contours on top of pay are shown in Figure 18-1. The south productive limit is a water contact. The north productive limit is 200 feet higher than the elevation of the water contact. The east and west ends of the reservoir are limited by impermeable nonpay. The trap is called the L-1 reservoir. The variation of strike length with structural position is nominal, so the trap is classified as a linear reservoir.

Contours on bottom of the L-1 reservoir are shown in Figure 18-2. The productive limits on the east, west and north sides coincide with those in Figure 18-1. The vertical lines A-A′, B-B′, and C-C′ are traces of the sections in Figure 18-3.

The pay thickness contours are given in Figure 18-4. The productive area enclosed by the zero contour is 7050 acres. The average pay thickness for this area is 27.1 feet. The L-1 reservoir contains 191,000 acre-feet of pay.

Table 18-1.—Basic Data for the L-1 Reservoir

Productive area, acres	7050
Average pay thickness, ft.	27.1
Acre-feet of pay	191,000
Average depth, ft.	10,000
Average porosity, percent	22
Average permeability, mds.	200
Average interstitial water, percent	25
Reservoir space, bbls./acre-foot	1280
Reservoir space, million bbls.	244.48
Reservoir pressure, psia	4490
Reservoir temperatures, °F.	200
BPMM at 4490	135.9
Bbls. space/bbl. C_{4+}	5.11
In place C_{4+}, million bbls.	47.84
MCF of rich gas/bbls. C_{4+}	7.358
In place rich gas, billion ft.	352.0
MCF of propane and lighter/bbl. C_{4+}	6.475
In place propane and lighter, billion feet	309.8

Pass horizontal planes at various levels in the L-1 reservoir and planimeter the productive area and acre-feet of pay above the planes. The results are mapped out in Figure 18-5. The productive area above the 160-foot level is 1090 acres. But the pay thickness averages only 4.6 feet.

The basic data for the L-1 reservoir are itemized in Table 18-1. A 22 percent porosity, 200 millidarcy permeability and 25 percent interstitial water are assumed for illustrative purposes. There are 47,840,000 barrels of condensate in place. The in place rich gas is 352 billion feet.

One barrel of butanes plus occupies 5.11 barrels of reservoir space and 7.358 MCF of rich gas yield one barrel of butanes plus. The volume factor is 0.694 barrels of space per MCF of rich gas.

Table 18-2.—Estimated Drawdown for 10 Million/Day

Reservoir pressure, psia	4490
Reservoir temperatures, °F.	200
Compressibility factor	0.938
Viscosity, centipoises	0.04
Well interference factor	0.64
Half distance to wells, ft.	5000
Radius of well bore, ft.	⅓
Log 2d/r	4.48
Average completion in pay, ft.	20
Average permeability, darcys	0.2
$P^2_r - P^2_b$, million*	1.42
$P^2_b = 20.16 - 1.42$	18.74
P_b, psia	4329
Drawdown, psi	161

* Assume F = 0.284Q after condensation.

Table 18-3.—Producing Wellhead Pressure for 3-inch Tubing

Length of tubing, ft.	10,000
Average temperature, °F.	180
Average compressibility factor	0.9
Gas gravity	0.98
$S = 0.0375(0.98)(10{,}000)/640(0.90)$	0.647
e^S	1.906
$15.1/D^{5.23}$	0.0489
$R = 0.0489\ 640(0.9)Q^2$	$0.0162Q^2$

Million/day/well, Q	10	20	25
$F = 0.284Q$	2.84	5.68	7.10
P^2_b	17.32	14.18	13.06
P_b, psia	4160	3800	3610
Drawdown, psi	330	690	880
R in millions	1.62	6.48	10.13
$R(e^S - 1)$	1.47	5.87	9.18
$E = F + R(e^S - 1)$	4.31	11.55	16.28
$P^2_w e^S = 20.16 - E$	15.85	8.61	3.88
P^2_w	8.31	4.52	2.04
Wellhead psia	2880	2120	1430

The compressibility factor for rich gas is 0.938. Rich gas gravity is 0.9814.

The L-1 reservoir producing rate will now be optimized on the basis of pressure maintenance with water and with gas sales at three cents per MCF. Minimum producing wellhead pressure is taken at 1000 psia. Maximum water injection wellhead pressure is 2000 psia. A noncycling plant and centrifugal pumps driven by gas engines will be used. Sales gas after shrinkage and fuel is 800 MCF per million feet of rich gas production. Peak sales are taken at 20 percent above the annual average sales. The required injection, producing and plant capacities are 20 percent above the annual average. Annual average is taken at the L-1 reservoir optimum rate for pressure maintenance with water.

In order to estimate the drawdown, assume a 10 million barrels per day producing rate. Then the bottom-hole operating pressure may be obtained as in Table 18-2. A 161 psi drawdown is indicated for a ten million barrels per well daily rate. The corresponding formation factor F equals 0.142.

However, a 40 million barrels per day

Table 18-4.—Estimated Buildup for 5000 Barrels/Day

Viscosity, centipoises	0.70
Well interference factor	0.64
Completion efficiency, percent	50
Well-reservoir permeability, darcys	0.16
Average completion, ft./well	60
Well reservoir permeability, darcys	0.16
Log 2d/r	4.48
Estimated buildup, psi	830
Bottom-hole injection pressure, psia	5320

Table 18-5.—Injection Pressure for 5½-inch Casing

Length of casing, ft.	10,000
Static pressure, psi	4330
Average I.D., inches	4.70
$(4.7)^{5.23}$	3274

Thousand bbls./day/well	5	10	15
$F = 830Q/5000$	830	1660	2490
P_b	5320	6150	6980
$P_b - 4330$	990	1820	2650
Friction psi $= 7.88 \times 10^{-7} Q^2$	20	80	180
Wellhead psia	1010	1900	2830

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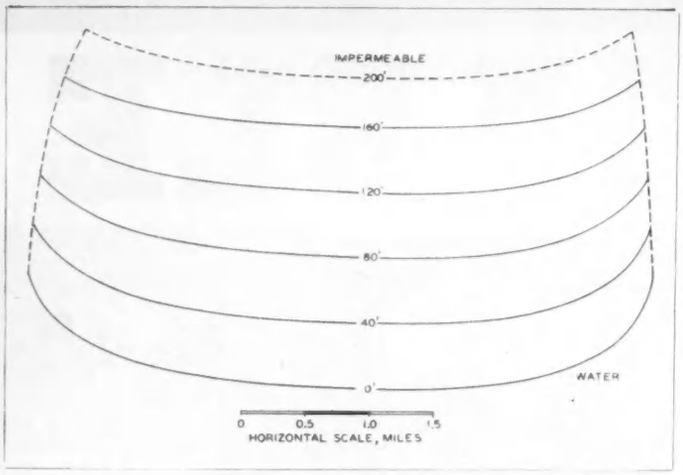
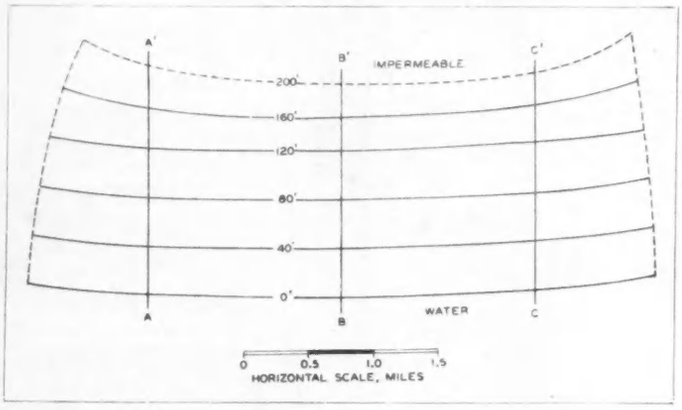
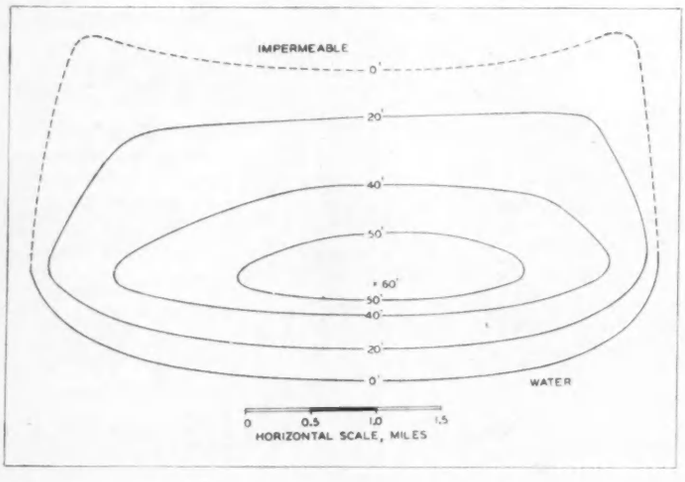






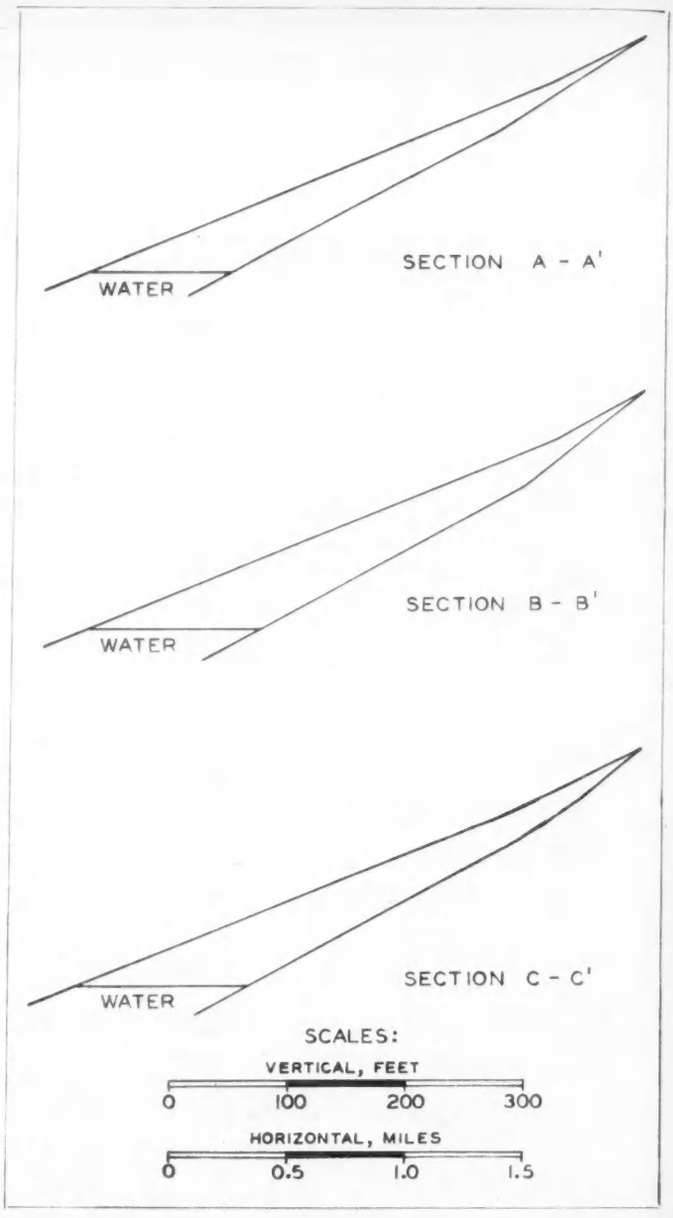


FIGURE 18-1 (top left). Contours on top of the L-1 reservoir.

FIGURE 18-2 (center left). Contours on bottom of the L-1 reservoir and traces of the sections in Figure 18-3.

FIGURE 18-3 (right). Vertical sections A, B, and C for the L-1 reservoir.

FIGURE 18-4 (lower left). Pay thickness in the L-1 reservoir.

per well rate would have a bottom-hole operating pressure on the order of 85 percent of dew-point pressure. The liquid content in the gas phase entering a well may be about 105 barrels per million. About 30 barrels per million is likely to condense in the immediate vicinity of producing wells. An accumulation of some liquid may decrease the effective well-reservoir permeability from 200 to 100 millidarcys. For this reason a formation factor equal to twice 0.142 or 0.284 is assumed.

In view of the reservoir capacity, 3-inch nominal size tubing may be used for producing wells. The approximate producing wellhead pressures, see Table 18-3, for ten to 25 million barrels per day per well range from 2880 to 1430 psia. A twenty million barrels per well daily average capacity will be used in estimating the optimum producing rate for L-1.

The estimated buildup for 5000 barrels per day per well is 8300 psi initially, Table 18-4. The estimated injection wellhead pressure for 5½-inch casing is 1000 psia for 5000 and 1900 psia for 10,000 barrels per day per well initially, Table 18-5. In view of prospective plugging, 5000 barrels per day per well injection capacity will be used in optimizing the producing rate.

Investment and Operating Outgo

Producing wells rated at 20 million barrels per day have enough rubber in them to meet peak demand. The per producing well plant requirement is 24 million barrels per day at peak load. The water requirement per 20 million producing well is 20 (700) or 14,000 barrels per day. With plugging, down time and peak demand, three injection wells per producing well may be required ultimately.

The investment in a noncycling plant at $20,000 per million daily capacity is $480,000 per producing well. The well investment at $100,000 per well is $400,000 per producing well. The water plant investment at four dollars per barrel daily capacity, including peak load, is 1.2 (14,000) (4.0) or $67,000. The total investment is $947,000 per producing well. We might note that a plant should not be oversized if the duration of a

peak demand is a small fraction of any year. Increase throughput and lower extraction efficiency during short peaks in lieu of oversizing a plant.

The annual gross income from condensate at $1.80 per barrel is 1.8 (20) (365) (135.9) or $1,785,000 per producing well. The corresponding value for sales gas at three cents per MCF and 800 MCF per million is 0.8 (20) (365) (30) or $175,000. The combined gross annual income is $1,960,000.

The annual operating expense for the noncycling plant is about $48,000 and for the water plant, $47,000. So the field operating expense is 95/1960 or 4.85 percent of gross income. Royalty, taxes and a reasonable overhead added to field costs give 25 percent for the operating outgo.

Optimum Uniform Rate

Figure 18-5 shows the acre-feet of pay invaded by water in terms of the gas-water contact elevation in the L-1 reservoir. Production is likely to be by edge water until water reaches the 120-foot level. About 86 percent of the total acre-feet of pay is between the zero and 120-foot levels. Water can displace 98 percent of the in place gas. Accordingly, the condensate reserve is 98 (0.86) or 84 percent relative to edge water. The ultimate recovery may reach 95 percent of in place rich gas. But the contribution to the optimum rate by the recoveries above 84 percent is comparatively small and will be neglected.

The ratio X of annual gross income to investment is 1960/947 or 2.07. The product X(1 — B) is 2.07 (0.75) or 1.55. The optimum uniform rate of production corresponding to 1.55 and an 84 percent reserve is about 12 percent per year of in place rich gas or 120 million per day.

Figure 18-6 shows the producing and injection wells. Average 120 million per day from six wells. Condensate production is 16,000 barrels per day. Sales gas averages 96 million per day.

Twelve injection wells are located in a few feet of gas pay in order to flow them for cleanout purposes before water injection is started. The required 84,000 barrels per day of water can be put away through twelve wells initially. With plugging six additional wells may be required ultimately.

The section in which injection wells are completed varies from 80 to 30 feet. The per-well relative injection rates are approximately proportional to per-well completions. Accordingly, inject at approximately uniform wellhead pressure. Gravity will maintain water advancement approximately parallel to the contours on bottom of pay. Use Figure 18-5 to estimate the location for such additional injection wells as may be required.

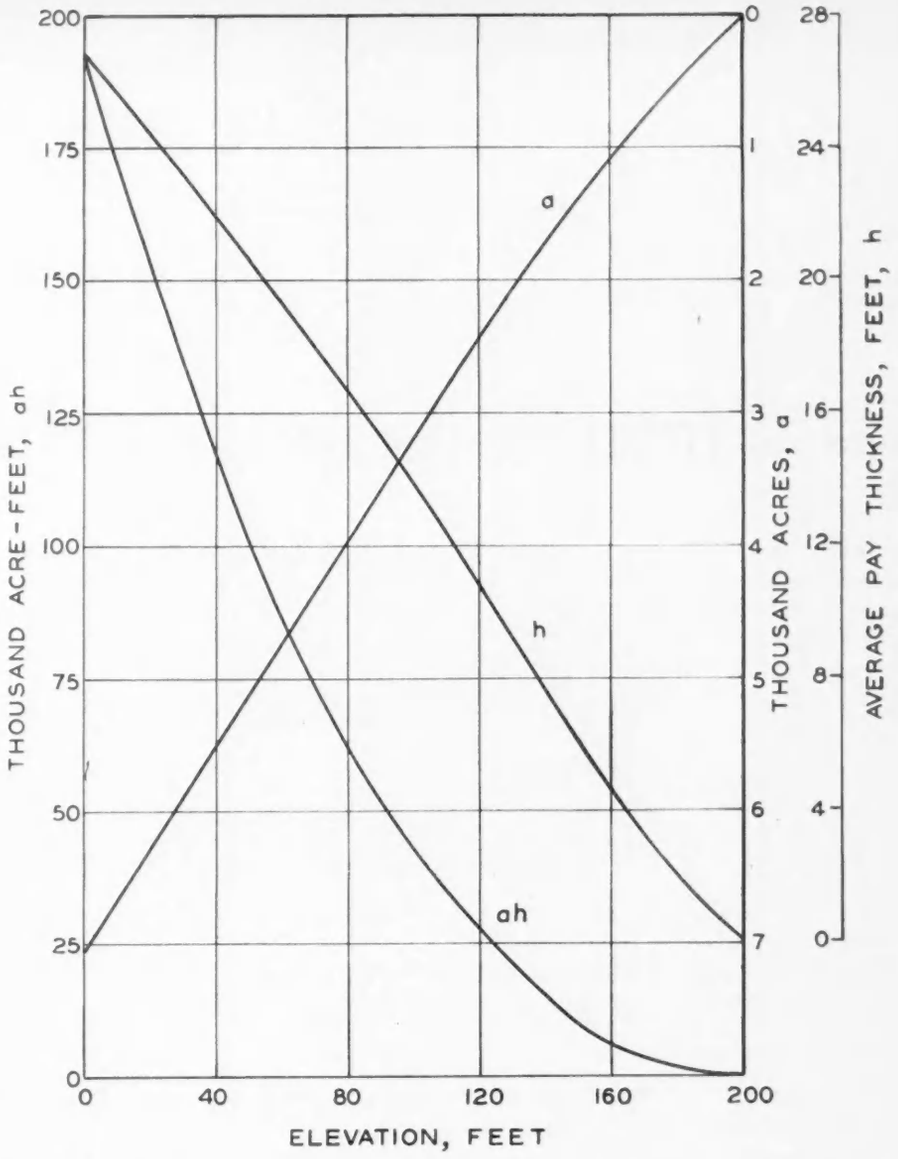


FIGURE 18-5. Productive area (a), average pay thickness (h) and acre-feet of pay (ah) vs. elevation in the L-1 reservoir.

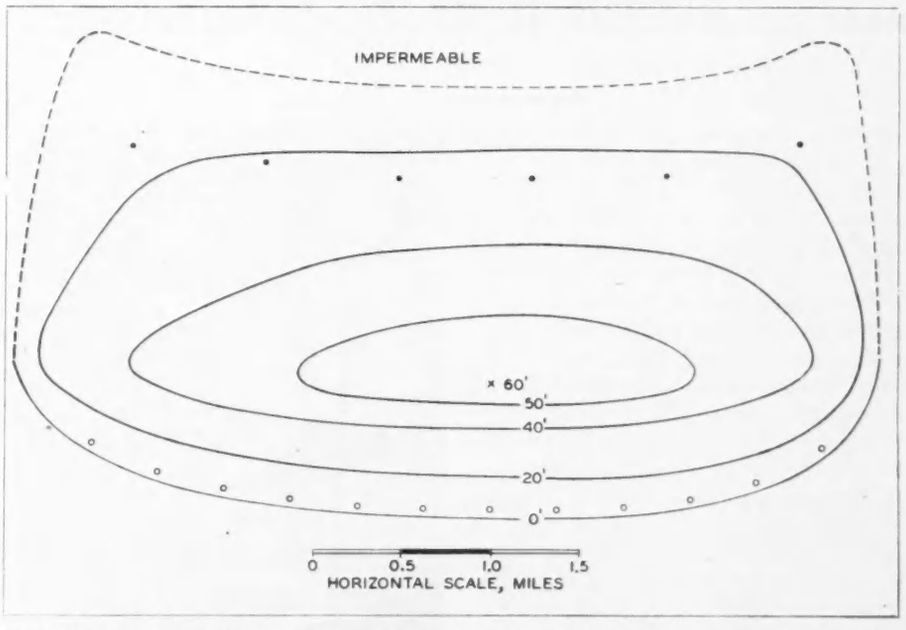


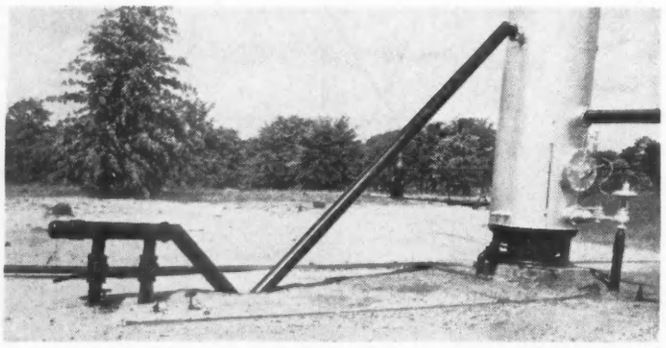
FIGURE 18-6. Produce 120 million/day through six wells; inject 84,000 barrels per day of water through 12 wells initially; drill six additional water injection wells if and as needed.

How to do it!

PRODUCTION HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Protect Well Flow Line Valves from Separator Vibrations



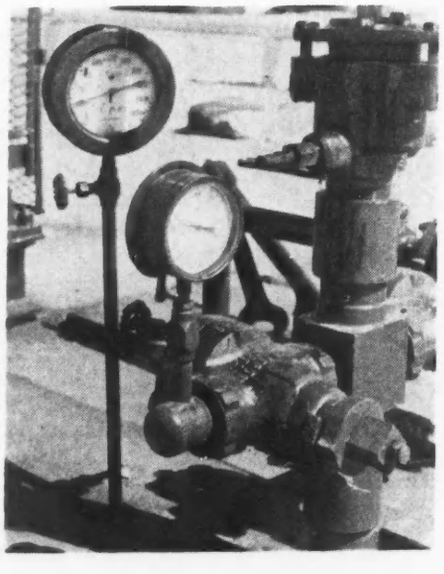
Well flow line valves are protected from separator vibration in an ingenious manner by one East Texas producer. Instead of running the connection to the separator from the top of the flow manifold at the most direct angle between inlet and manifold, the line is led downward at 45 degrees to ground level, where a short horizontal section is welded in. The line then rises at the correct angle to the level of the separator inlet.

The short horizontal section at or slightly below ground level is welded to a transverse piece of six-inch pipe, some two feet in length. This unit, buried in the sand, acts to absorb all the vibration imposed on the riser by separator operation, and thus protects the threaded connections of the well flow lines against thrust or load other than that imposed when the lines are made up.

In clay or rocky soil, the anchor is set into a small pit, and sand used to fill in around it to form the desired cushion. Where the terrain is sandy, the only precaution necessary for successful anchoring of the flow system is to fill in around the anchor with dry sand at a time when the pit or hole is dry. If the soil is actively corrosive, the anchor is dipped in coal-tar pipe preservative, or two or more hot coatings applied by the brush after the tack weld is made attaching the cross member to the short horizontal run in the flow line.

HOW TO—Minimize Errors Due to Carelessness in Reading Gauges

Few leases escape the effects of carelessness or outright "dog-housing" of production records. Field personnel whose duty it is to obtain data and maintain continuous records of well pressures, flow records, etc., often turn in field reports which include a figure or two which appears to be entirely out of line with data obtained in previous tours. To the supervisory official or superintendent, such figures mean either that something actually did happen to the well to cause the different reading, or that an error was made in reading the gauge or chart. In either case, it usually means that an extra trip must be made to the field to double-check the figures.



To help eliminate some of the errors attributable to the human element, one company has adopted the practice of having the field man draw a line across the face of the pressure gauge immediately above the needle, using a wax pencil, red or black, which leaves a line that will not wash off with rain or damp air. If the well is known to be more or less stable, the line is allowed to remain there, each pumper or field man then being able to see at a glance that the condition was unchanged since the last time the well was visited.

The drawn lines prevent a pumper from mis-reading the gauge by increments of 50 or 100 pounds, a mistake easily made when gauges of different pressure increments are used, and cause him to more carefully check his records to see that they are not out of line with those taken on the previous tour.

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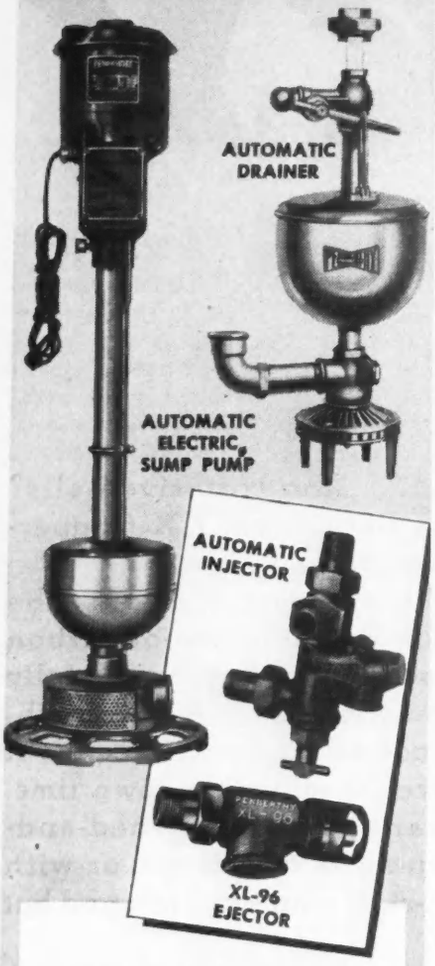

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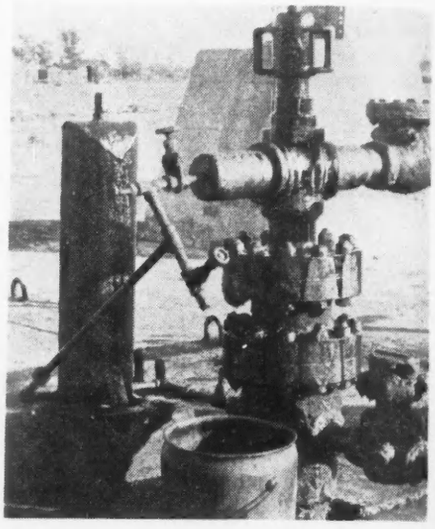
HOW TO—Build Blowcase for Chemical Feeding

After having experimented with several methods of introducing paraffin solvent into pumping wells, a pumper on one lease designed and built a blowcase which has been quite successful for feeding chemicals into the well. The case is simply a short nipple of ten-inch pipe set on a flat base so it may be placed near the casinghead. One-inch connections at the base and on opposite sides of the case are used to attach lines, one leading from the lead line cross below the polish rod stuffing box to one side of the case and the other from a fitting in the casing below the wellhead to the other side of the case.

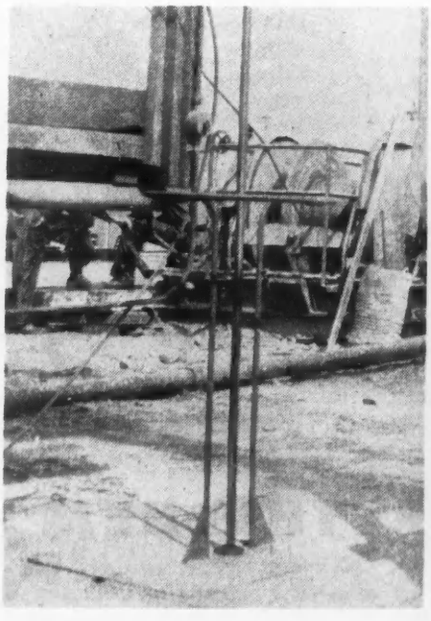


Control valves are connected for shutting off the case from the lead line and the casing. A nipple in the top of the case is used for pouring the paraffin solvent into the case, after which it is closed with a bull plug. To operate the case after filling, the pumping unit is throttled to pump slowly, and the lead line gate valve closed. Both valves on the inlet and outlet lines of the case are opened to permit pumped oil to circulate through the case until all the chemical is lubricated into the well through the casing. Sufficient oil is pumped down the pipe through the annular space between the tubing and the casing to insure all of the chemical being washed down to the productive sand.

HOW TO—Guard Polish Rod From Damage

Wells which are pumped through covers upon cellars in which the Christmas tree or casinghead is installed can be equipped with a removable guard which surrounds the polish rod to protect it from damage and prevent accidents. The floor which covers the cellars on one lease is made in removable sections designed so that men may open sections as desired instead of using a gin pole to lift an exceptionally heavy platform. Immediately above the top fittings on the wellhead is a small rectangular cover cut in half, each fashioned from skid proof walk-way steel and having a small, round hole in the center, immediately above the polish rod stuffing box. Steel rod standards, one to each half of this cover are welded securely with gusset braces to the covers and extend hip-high to an average man to terminate as half circles completely surrounding the polish rod when placed in operating position.

These guards are heavy enough, with the floor plate attached to resist considerable pressure if a pumper should bump into them. When the wellhead is to be exposed, each half is lifted away and may be easily replaced after adjustments or repairs have been made.



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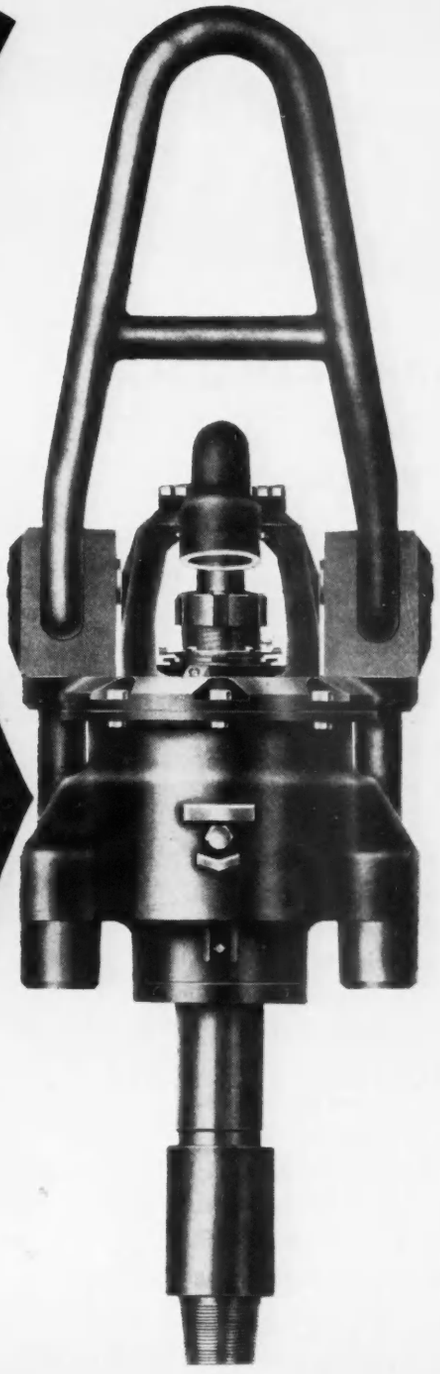

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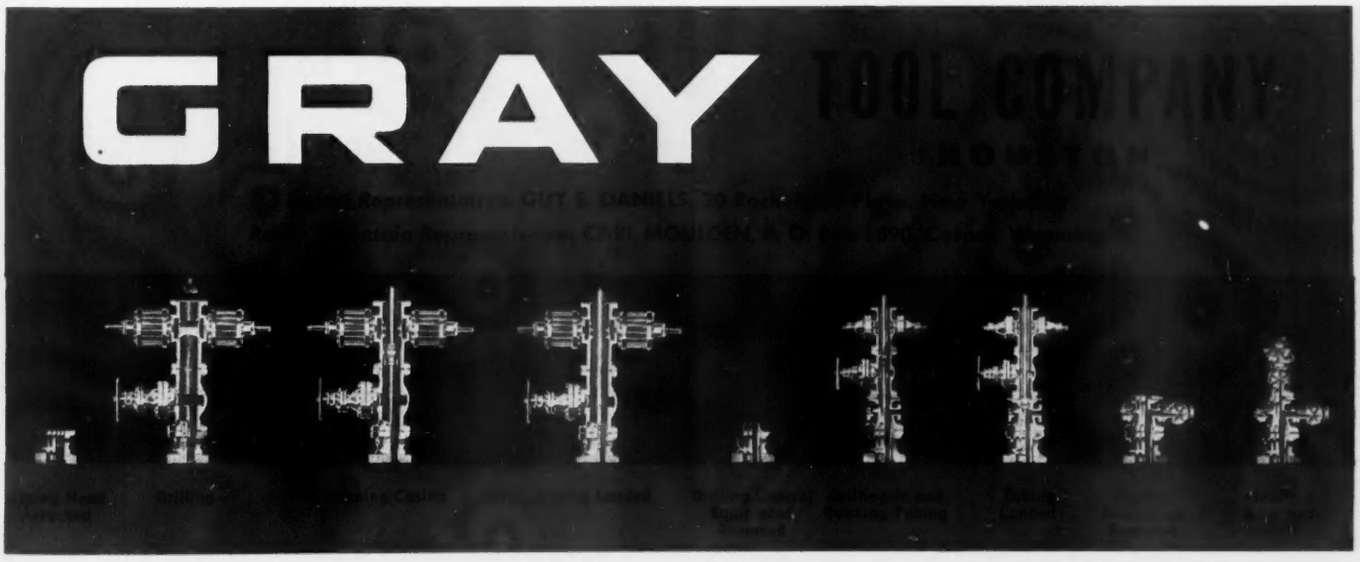

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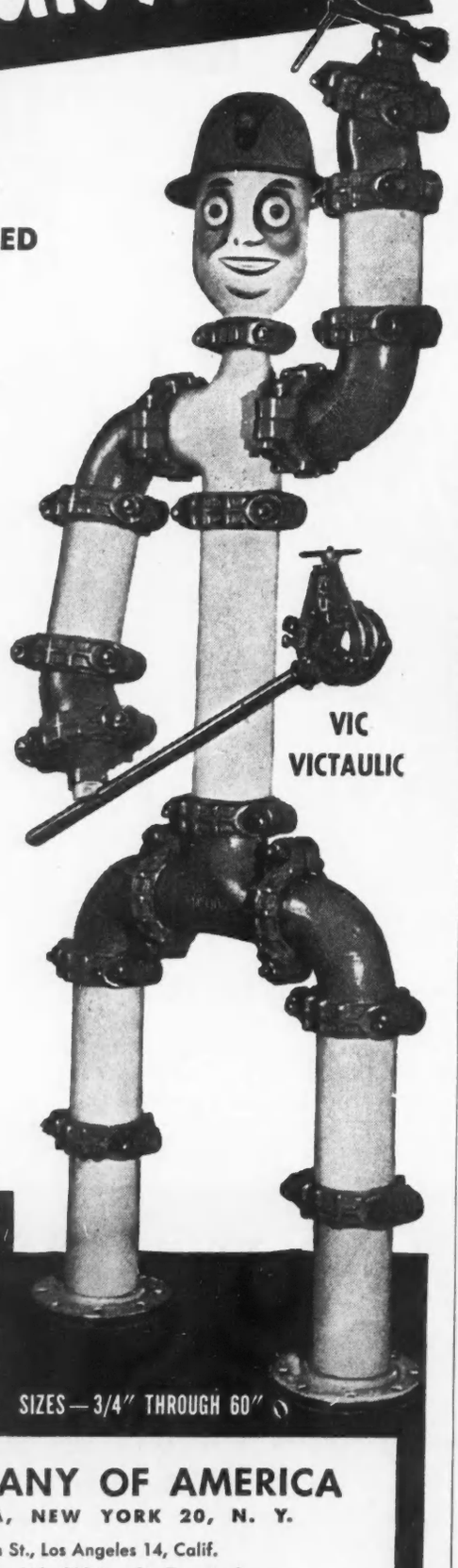

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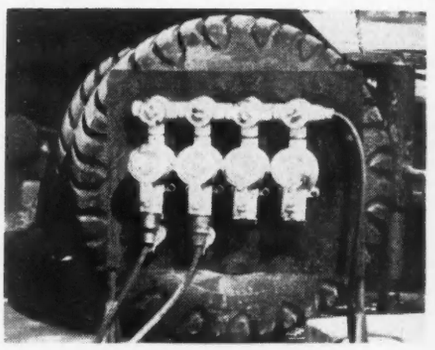
HOW TO—

Centralize Cable Outlets

To make it easier for the crew to plug in several flood lamps and perhaps a trouble lamp to assist the mechanic when making rig repairs at night, one company has assembled conventional plug-in fixtures in a manifold which can be moved to any point desired. The fixtures are similar to those permanently attached to buildings for plugging-in extension lamp cords and are attached by an electrician to a panel supported by two substantial legs resting on a base made of light channel iron.



The "hot" side is made up through metallic conduit in which the master extension cord is carried, it having conventional approved fittings to plug into a current supply socket existing on many leases supplied with high-line power. Use of this manifold takes the place of a hazardous practice of splicing several extension cords to one master cord which might under certain conditions lead to disastrous fires and injury to workmen on the rig.

HOW TO—

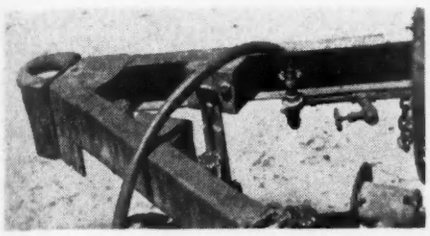
Protect Fuel Connections

In order to minimize possibility of rupturing flow lines or spigots on a compartmented trailer-mounted fuel oil tank which is hauled to the site of well pulling operations to service motorized equipment, one company found it advantageous to terminate the lines at the draw-bar end of the trailer instead of along the side or exposed rear of the tank.

Two separate lines, each protected by the channel iron frame of the trailer,

PRODUCTION HINTS

are brought up to the enclosed area formed by the joining of the frame members. Whether for fuel oil, cleaning solvent, or other liquids, each line is equipped with several valves or union connections to permit rapid connecting to lines when withdrawing the fluids.



The convenience of these centralized outlets is matched by the reduced fire hazard, for exposed valves or lines easily are ruptured or damaged by falling objects or the rough handling to which they are subjected from time to time.

The trailer draw bar has a hinged leg fitted to it, the latter being dropped down to support the trailer horizontally when the unit is set up at a location.

HOW TO—

Save Time in Servicing Enclosed Pumping Unit

In order to save the pumper the time and trouble required to move heavy screened panels or guards whenever the wrist pins of a pumping unit must be lubricated, one company has provided a small rectangular opening in each of the side guards through which he can operate the grease gun. The opening is reinforced with a rectangular steel frame welded to the expanded metal screen. Two hooks welded to the top of this frame serve as a hinge for the vertically-opening small door. The pumper, in shutting down the unit for servicing, causes the crank pin to stop opposite the opening, thus making it unnecessary for him to enter the enclosed area.

The hinged panel is slightly longer than the opening so it will not swing on into the enclosure, causing the opening to remain closed until deliberately opened by the pumper.

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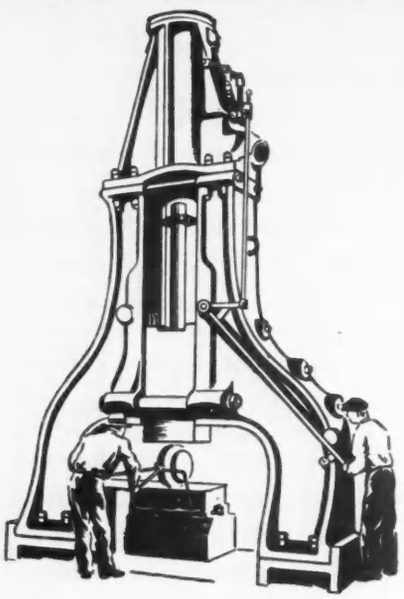

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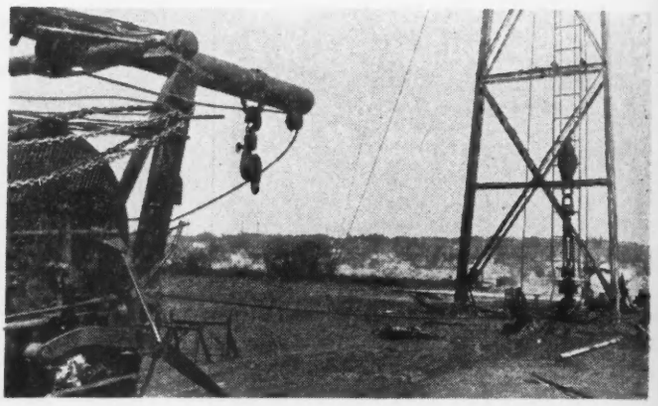
HOW TO—Simplify Carrying Tubing Blocks



A simplified method of carrying the blocks and similar heavy pieces of the pulling equipment is employed by the crew of a West Texas well production service company. Near the base of the pulling unit mast is hung a small snatch block. When the job is completed at a well, the blocks are hooked to the small block, and when the mast is laid down, the blocks are picked up, remaining in this position until the rig is set up at the next well.

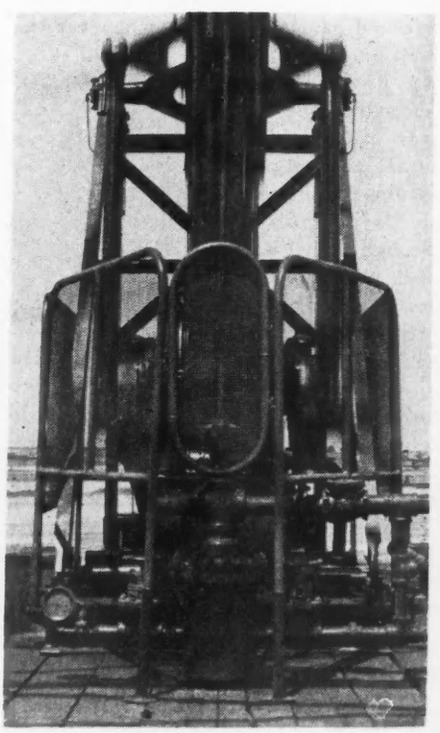
For general lease travel and short highway trips, this method of handling the blocks not only is convenient but requires very little time for routine rigging up and tearing down. Inasmuch as stringing up the blocks and taking them down are among the first and last jobs to be done at a well, the system of hanging up the tools in this manner simplifies those operations appreciably.

HOW TO—Include Safety Gate on Pumping Unit

To promote safety for employes at pumping wells, one company has devised an enclosure for the entire unit with a provision for servicing the stuffing box without the pumper entering the enclosed area. Panels are covered with heavy wire mesh so that injury to the employe by moving parts is eliminated.

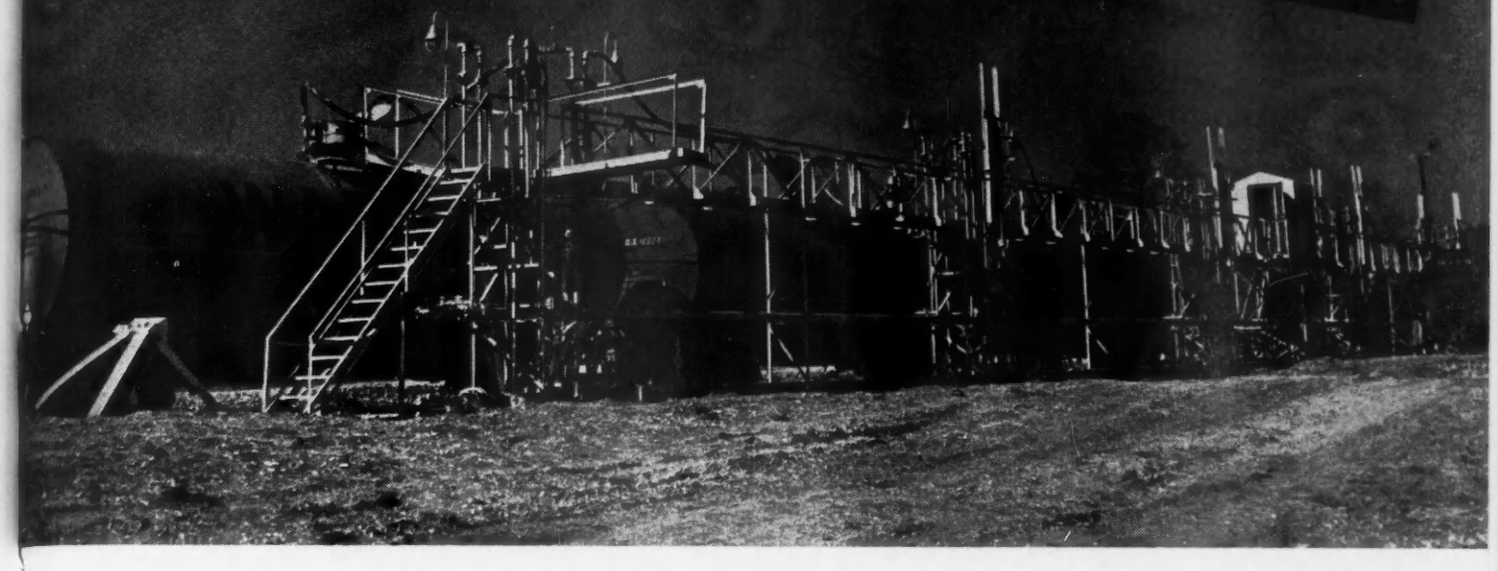
At the front of the unit, side panels are drawn closely together leaving a space sufficiently wide for removing and replacing stuffing box packing, or servicing the horse-head when on the down stroke as the unit is shut down.

The narrow panel closing this opening is fitted with pin hinges on one side and a latch on the other, but designed so that the entire panel can be removed easily if necessary. By providing only this one service opening, the pumper, or repairman, automatically stands in front of the stuffing box safely clear of any part which is moving or which may move suddenly due to the weight of the sucker rods after a shutdown.



NORSWORTHY FIRST DOCK-SIDE LPG TERMINAL

by J. E. KASTROP, Staff Writer



Railroad tank car unloading rack capable of accommodating 61 cars, 12 of which may contain butane or propane, while the remainder contain natural gasoline. The pressure in each tank car is equalized with the pressure of the tank receiving the product.

THE LIQUEFIED PETROLEUM GAS industry has grown by leaps and bounds since its early beginning in 1926. LPG has become an important fuel in the daily economy of many industries and thousands of individuals. Warren Petroleum Corporation's Norsworthy Terminal is only a part of the industry's expansion program to meet the growing demands for LPG. The new terminal now has a capacity of 57,000 barrels of LPG, and when present construction is completed, this capacity will total 67,850 barrels.

IN THE liquefied petroleum gas industry, whose phenomenal growth is almost without parallel, there is room for many "firsts." One outstanding "first" is Warren Petroleum Corporation's Norsworthy Terminal on the Houston Ship Channel ten miles east of Houston. This is considered the first liquefied petroleum gas terminal of its kind designed and constructed to serve both land and sea outlets. Propane, butanes, and natural gasoline are received from various sources through pipe lines, by railroad tank cars, and by tank truck. These products are stored at the terminal for disposition by pipe line to nearby refineries and chemical plants and by tank ship to the East Coast.

From this terminal, the "S.S. Natalie O. Warren," largest LPG tank ship afloat and the first constructed solely for transporting propane and other LPG, takes on her cargo of these products for delivery to Warren's LPG terminal at Newark, N. J. Construction of this 70,000-barrel receiving terminal at Newark is nearing completion. It consists of 100 tanks of 30,000 gallons water capacity each.

Construction of the new propane and butane storage and pumping facilities which make the Norsworthy Terminal significant began in November, 1946, and was completed in August, 1947, by Delta Engineering Corporation of Houston. Completion of this project provided storage capacity for 46,000 barrels of propane and 11,000 barrels of butanes. Forty-seven horizontal high-pressure storage vessels approximately 80 feet long and ten feet in diameter provide storage for the propane. Butanes are stored in two spherical tanks. At this writing, construction has begun on 14 horizontal tanks to provide 10,850 barrels additional propane storage, making an ultimate total storage capacity of 67,850 barrels of propane and butanes at the terminal.

The terminal consists of two 100,000-barrel capacity spheroids, one 38,000-barrel capacity radial cone tank, and one 55,000-barrel radial cone tank. These four tanks, totaling 293,000 barrels capacity, are used exclusively for the storage of natural gasoline. With the completion of the 14 horizontal tanks for propane storage, the terminal will have

a storage capacity of 360,850 barrels of all products.

	Barrels
Natural gasoline storage capacity	293,000
Propane storage capacity	46,000
Butane storage capacity	11,000
Total storage capacity at present	350,000
Additional propane storage capacity under construction	10,850
Total ultimate storage capacity	360,850

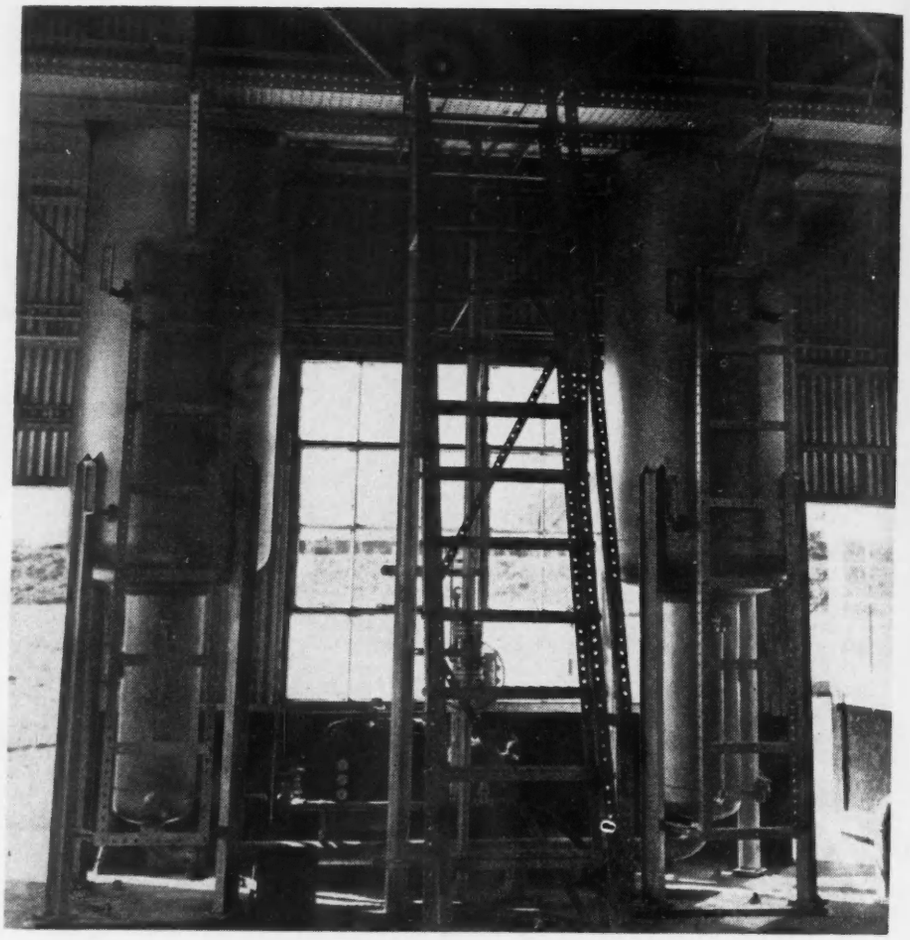
Receipt and Disposition of Products

Natural gasoline, propane, and butanes are received at the terminal by pipe line, railroad tank cars and tank trucks. An eight-inch pipe line brings in the products "batchwise." These enter the pump house first through vertical pressure strainers, and then are metered and transferred to proper storage. The railroad tank car unloading rack is capable of accommodating a maximum of 61 cars, 12 of which may be propane or butane, and the remainder natural gasoline cars.

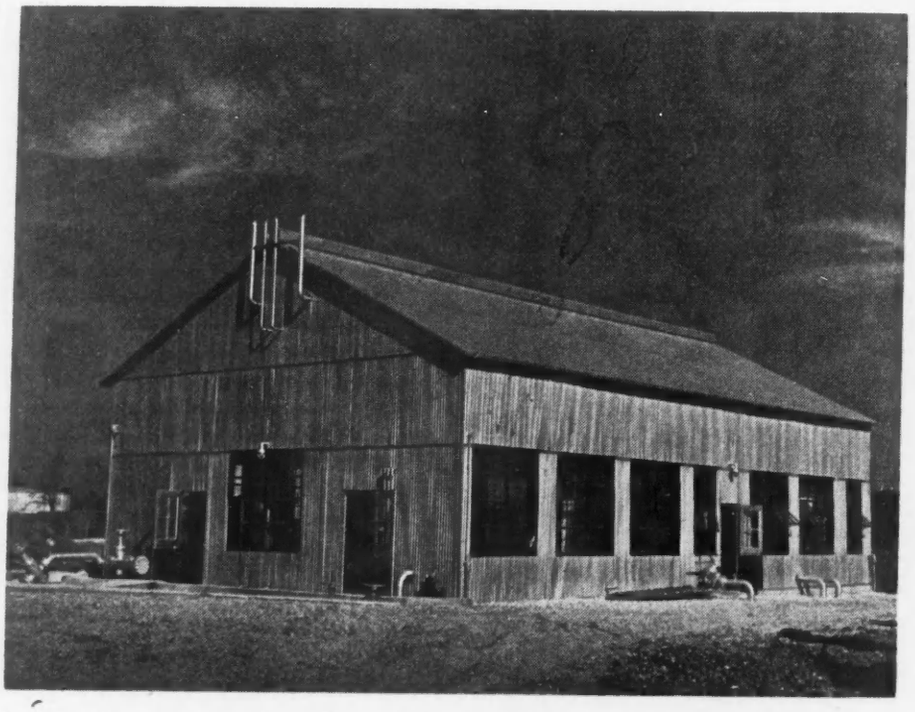
Natural gasoline flows by gravity through a 16-inch suction line to the pump house where it is picked up by the pumps and transferred to storage. Propane from the railroad tank cars is handled in much the same manner through a ten-inch line. Pressure in the tank car and in the storage vessel is equalized before discharge begins. After the liquid propane has been removed from the tank car, the propane vapors in the car are removed with compressors until the pressure is 25 pounds per square inch.

There are two tank truck docks capable of loading or unloading natural gasoline or LPG. Each truck dock is equipped with two 4-inch lines leading to the pump house: one line for loading, the other for unloading. A centrifugal pump at the natural gasoline truck dock transfers the product from the trucks to storage. This pump eliminates communication between the pump house and truck docks and substitutes for the main truck dock pump. However, it is possible to use the pumps at the pump house for making this transfer.

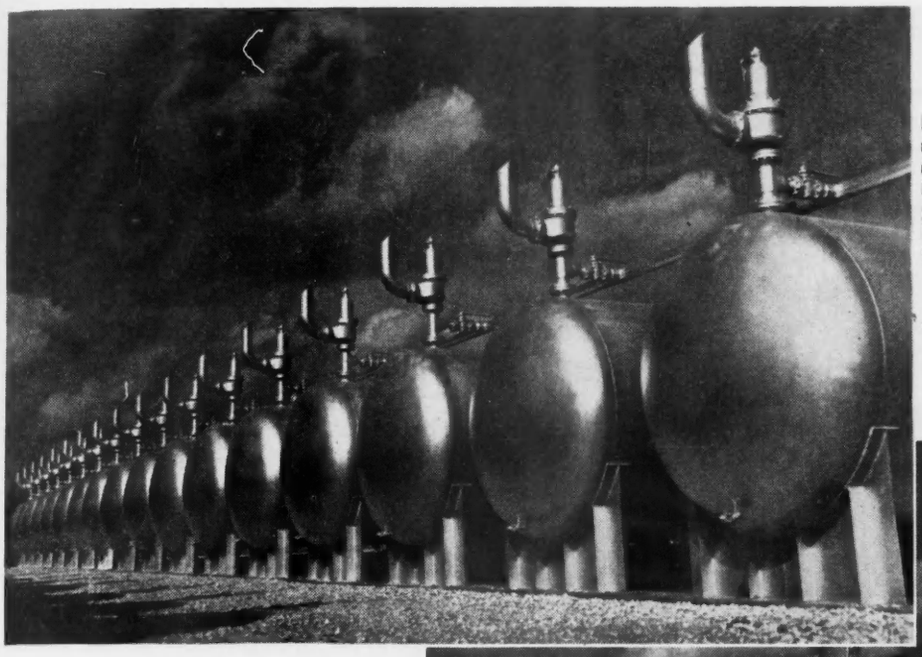
Design of the terminal makes the disposition of these products equally as flexible as the receipts of such products. Normal discharge of products from the terminal is either by pipe line to adjacent refineries or to Warren's Texas City terminal or by tank ship to the East Coast. The Texas City terminal is capable of handling both natural gasoline and LPG. Ten horizontal pressure vessels similar to those at Norsworthy handle all propane for distribution to the refineries and chemical plants in the area. From this



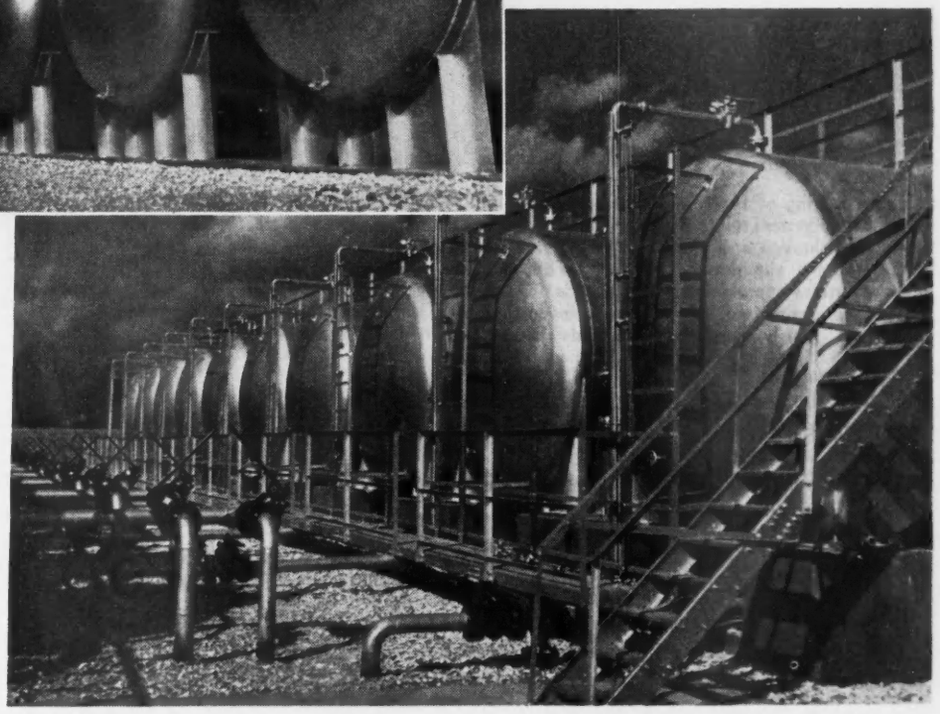
Calibration tanks used in checking and calibrating positive displacement meters. The relatively narrow necks at bottom and top of the tanks make it possible to obtain an accurate measurement of the tank's contents. Fluid is pumped in at the bottom of the tanks and is displaced out the bottom by the compressor located between the two tanks. Temperature of the fluid in the tanks is determined by two thermometers built into each tank. This temperature is applied to correct the volume to a 60° F. base to correspond with the temperature corrected volume indicated by the meter.



Exterior of the modern pump house. Constructed of structural steel and sheet metal, the pump house was built upon a very elaborate foundation which houses the pump wells located 18 feet below storage tank bottom. The incoming eight-inch pipe line is shown entering the pump house at extreme left. The high ceiling of the structure maintains a comfortable temperature inside, while the large windows provide ample light and ventilation. Basement of the pump house is ventilated by forced draft.



Neatness in appearance and efficiency in engineering design are well illustrated in the symmetry of one propane tank battery. The vapor lines connect each tank so that a uniform pressure will be maintained in all tanks of the battery. The six-inch relief valves on top of each tank are set to open at approximately 240 pounds per square inch.



Line up of propane storage vessels and flow control manifolds. Both discharging and receiving lines may be seen at left. The control valves have been set at an angle to permit the engineer to make quick and easy changeovers. They are so located that he is able to tell at a glance exactly which tanks are open and which are closed. Sturdy structural steel catwalks add considerable convenience to the station engineer who must keep a regular check on each tank.

terminal, natural gasoline can be loaded into tankers.

The ship dock alongside the Houston Ship Channel has connections for loading natural gasoline, propane and butanes through 12-inch, 10-inch and 8-inch lines, respectively. The pump station is capable of loading the "S.S. Natalie O. Warren" with propane at the rate of 4000 barrels per hour. Loading is completed in about eight hours.

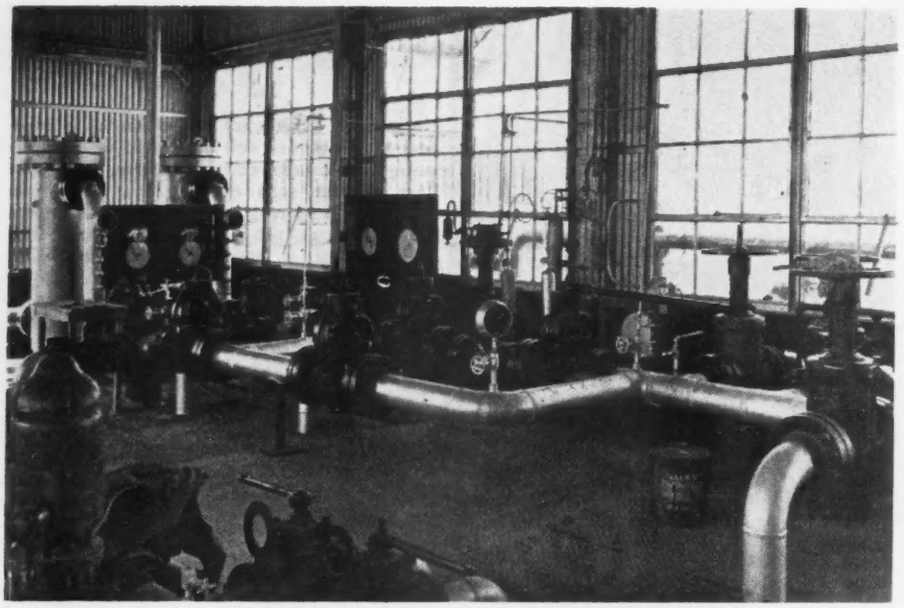
Measurement and Storage

Products arriving at the terminal through the eight-inch pipe line are measured either by storage tank gauging or by positive displacement meters, or if desired, by both. Receipts of natural gasoline and propane are scheduled somewhat on cycles; that is, the former product is pumped into the station until the supply storage is relieved, then a slug of propane is pumped into the line. Loss of products due to contamination is minimized by placing a slug of normal butane between the natural gasoline and the propane, since the slight contamination of natural gasoline by normal butane is more desirable than contamination by propane. The mixture resulting from commingling propane and normal butane is stored separately and marketed as LPG.

Products are pumped about seven hours each day through the pipe line into the terminal. By knowing the volume of the pipe line, the volume of a product to be pumped, the starting time of delivery from supply source and the rate of flow, the station engineer can determine when to be prepared to switch from one type storage tank to another with a minimum of contamination. The switch is made when the automatic gravitometer connected into the line indicates the expected change in specific gravity of the products being received. A drastic change in specific gravity of incoming products causes a siren to be energized, thus giving audible notice of the change.

Approximately 225 pounds per square inch back pressure is maintained on the incoming pipe line by a regulator to prevent vaporization of any propane that may be in the stream. The drop in pressure across the regulator depends upon the product arriving at the terminal and the storage tank into which it is being pumped. To prevent the flow of propane, with a vapor pressure of 124 pounds per square inch absolute at 70° F., into a low-pressure natural gasoline storage tank, a thermometer element is placed in the line just downstream of the regulator. If propane should accidentally pass the regulator when the incoming stream is manifolded to low-pressure gasoline or butane tanks, it would vaporize and cause an appreciable drop in temperature. This cooling effect causes the siren to sound and gives the station engineer warning of such a condition. This protective system reacts when the difference in temperature across the regulator exceeds 25° F.

An interesting feature of the metering system in the pump house is the calibration tanks, designed to check the accuracy of the positive displacement meters. Dual sets of strainers and positive dis-



Products arriving at the terminal through the eight-inch pipe line enter the pump house through this manifold system. Note the two strainers and positive displacement meters at far left. Fluid can be diverted through either combination strainer-meter while the other is being inspected and calibrated, thereby eliminating shutdowns. This manifold also contains the back-pressure regulator which maintains approximately 225 pounds pressure on the upstream line. To the right of the middle window and against the far wall may be seen the automatic recording gravitometer which continuously measures and records the specific gravity of incoming products.

placement meters are installed in parallel on the eight-inch pipe line so that either meter and strainer combination may be repaired or inspected without interrupting the flow of products into the terminal. This same dual system makes it possible to calibrate either meter without interfering with incoming products. These meters may be calibrated for natural gasoline, propane or butanes.

To make this calibration, it is necessary to pump the product from a storage tank, through the metering system, into the calibration tanks and back into storage. Circulation of the product continues until the thermal element in the meter (which automatically corrects volume to 60° F.) is at the same temperature as that of the calibration tanks and storage tanks. When the temperature of the complete system is equalized, the calibration tanks are drained of fluid to a level that can be observed in the gauge glass on the lower seraphin neck. At this point, readings are taken on both the tanks and the meter. Fluid is again pumped from storage through the meter and into the calibration tanks until the level can be observed in the gauge glass on the upper seraphin neck. With the measurements complete, temperature of the tanks is measured and corrections of volume are made to a 60° F. temperature base.

Pumping Facilities

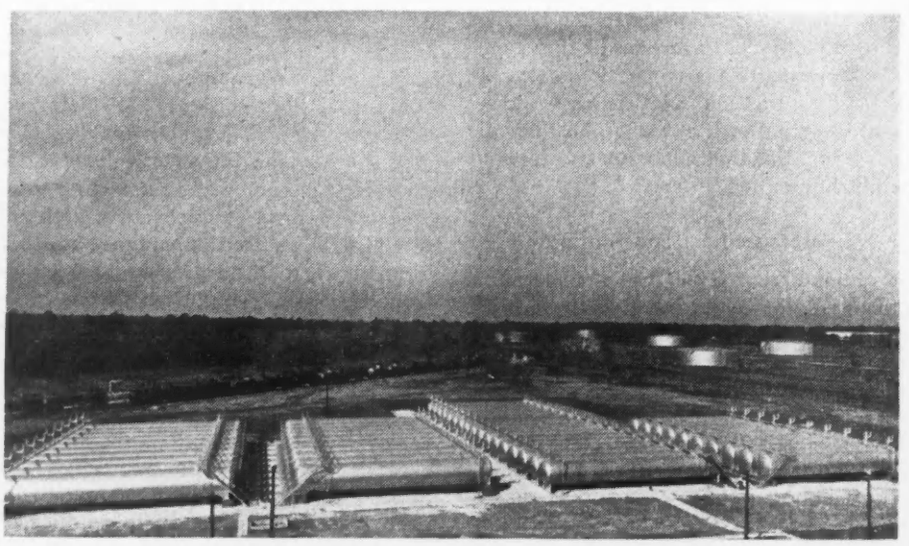
The pump house is equipped with eight electrically-driven, vertical centrifugal pumps. Two of these pumps are 100-horsepower, each with a capacity of 320 gallons per minute at a differential pressure of 350 pounds per square inch. There are three 75-horsepower pumps, each with a capacity of 1400 gallons per minute rated at a differential of 50 pounds per square inch. Transfer of products to and from the tank truck docks is handled by a 7½-horsepower pump. The remaining two pumps are of 15-horsepower each, and are used to unload railroad tank cars.

A unique feature of the centrifugal pumps is the method employed to release vapors from the pump suction wells. A standard automatic fluid drainer of the float type was installed upside down. When the drainer is filled with vapors only, a control valve opens, thus permitting the vapors to escape through vent piping into the atmosphere. When the pump well is filled with fluid, the float rises and stops the venting.

Flexibility of the pumps and storage facilities makes it possible to carry on several operations simultaneously. The terminal is designed to make possible the receipts of either propane or natural gasoline from railroad tank cars and tank trucks, while at the same time, products arriving by pipe line alternate from natural gasoline to propane and LPG. As these products arrive at the terminal, it is also possible to load the "S.S. Natalie O. Warren" with propane or a tanker with natural gasoline. It is still possible, simultaneously with the operations above, to pump LPG or natural gasoline to Texas City or to nearby refineries.

Laboratory Tests

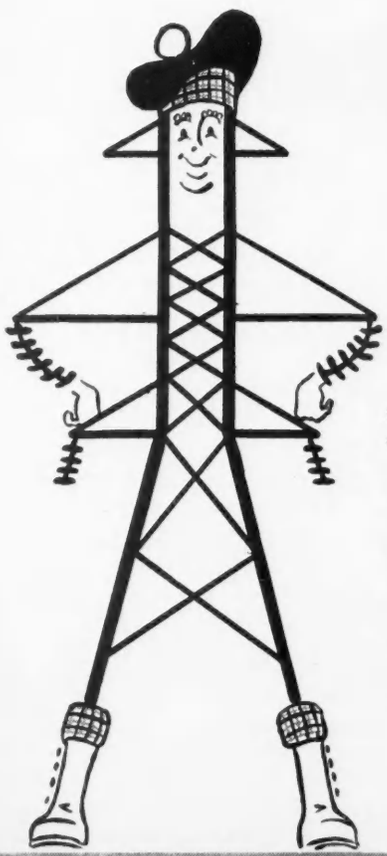
To insure the quality of all products arriving at and delivered from Norsworthy Terminal, several tests are made on each product. The tests listed below for each of the three different type products are made before they are discharged into the terminal as well as before they are pumped from the terminal. On all incoming and outgoing shipments of natural gasoline, the following tests are made: (1) distillation, (2) vapor pressure, (3) corrosion, (4) doctor test, (5) API specific gravity, and (6) Saybolt color test. Tests made on propane are (1) vapor pressure, (2) mercury freeze test, (3) cobalt-bromide moisture test, (4) lead-acetate test for hydrogen sulphide, (5) specific gravity, and (6) corrosion test. Butanes handled by the terminal undergo the following tests: (1) vapor pressure, (2) weathering test,



View of the newly-installed propane storage vessels, with railroad tank car unloading rack shown in the background. Ample space was provided during the original construction for expansion of propane storage facilities. Fourteen new propane tanks similar to those illustrated are now being added to those shown above, making a total of 61 high-pressure storage vessels.

LCP

FOR PIPELINES



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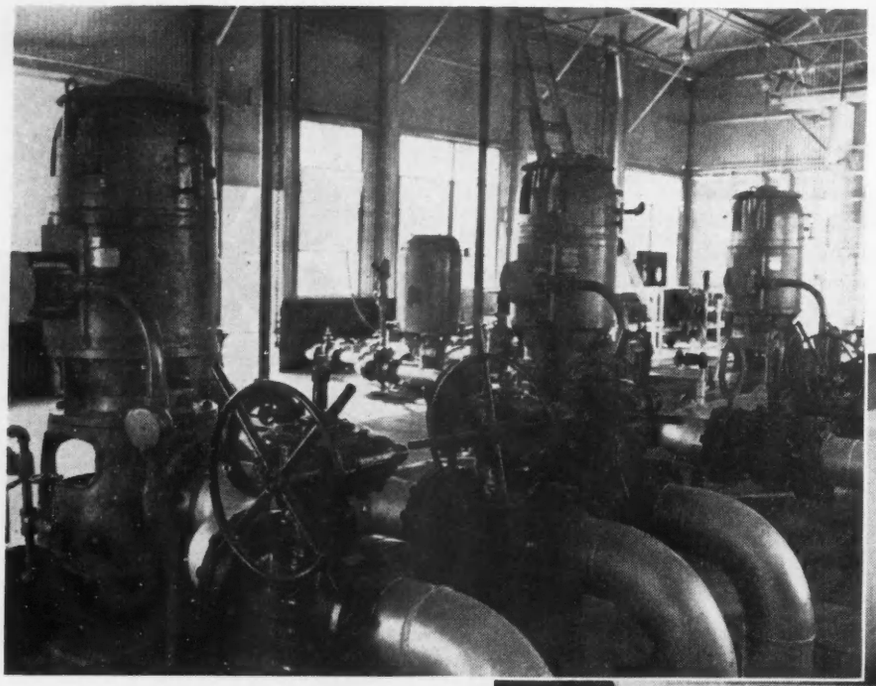
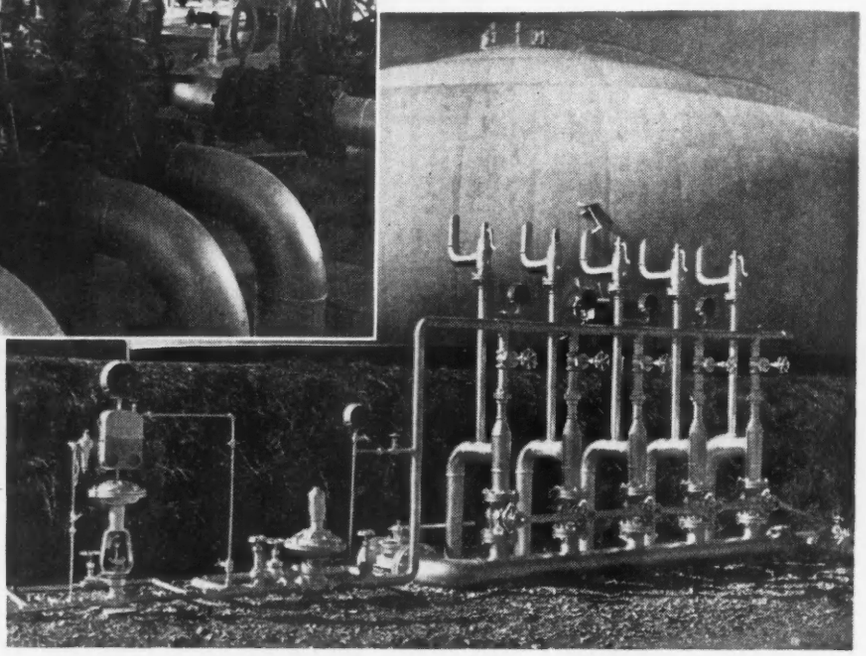


Four of the eight vertical explosion-proof electric motors that drive the centrifugal pumps may be seen above. Three lines from the discharge manifold provide outlets to propane, butane and natural gasoline systems. The three motors in the foreground are each 75-horsepower and have a delivery capacity of 1400 gallons per minute against a differential pressure of approximately 50 pounds per square inch.



Manifold for the efficient control of natural gasoline vapors. The top of each natural gasoline storage tank is connected to this manifold by a four-inch line. In addition, similar vapor lines are connected to the tank truck docks and to the railroad tank car unloading racks. Through this manifold, the vapor pressure in the storage tank and in the tank truck or railroad tank car is equalized when pumping from the truck tank or from the tank car into storage. When large withdrawals of natural gasoline are made, natural gas is supplied to the particular tank from which the withdrawal is made to maintain pressure on the tank. Relief valves are installed at the manifold for each vapor line in addition to the large relief valve on the storage tank.

(3) corrosion, (4) specific gravity, and (5) lead-acetate test.

Safety Considerations

Design and construction of the terminal included many safety features. Equipment handling propane exceeds many times the actual working pressures of the product. The horizontal propane tanks have a wall thickness of 0.84 inch or more, each equipped with six-inch relief valves set to open at approximately 240 pounds per square inch pressure. All tanks have been painted to reflect a maximum of heat, thereby reducing the temperature of the product and holding down the vapor pressure. The propane system contains only steel valves and seamless pipe, tested to 1000 pounds per square inch pressure. An extensive grounding system on the truck docks, the tank car unloading rack, and on the tanks themselves eliminate sparks due to static electricity, and also short-circuit lightning which may strike the tanks.

Dikes have been constructed around all storage tanks and are capable of holding almost double the capacity of the tanks which they enclose. An independent fire system was installed to fight grass fires which might bring a flame close to the tanks. The area in the immediate vicinity of the propane tanks has been completely covered with shell to prevent grass from growing. In the pump house, adequate measures have been taken to insure complete safety of operations. The electrical system is code for group one, class D (for hazardous locations), and all electrical motors are of the explosion-proof type.

At the ship loading dock alongside the ship channel, equipment was installed to stop instantly the flow of products in case the loading hose ruptured. This is accomplished by a regulator which is held open by the downstream pressure. The instant this downstream pressure is reduced, such as would occur in the case of a break in the hose, the regulator closes the line until the downstream pressure is restored.

Origin of Norsworthy

Norsworthy Terminal itself is not new, for it had its origin in 1933 when the total sales of all LPG in the U. S. amounted to less than 39 million gallons (928,000 barrels). Warren No. 1, the first tank, was constructed that year to handle the growing natural gasoline sales of the company. Until last year, the terminal handled only natural gasoline which was pumped through pipe lines to nearby refineries and shipped by tankers to more distant refineries for use as a blending agent in the manufacture of motor fuels. Versatility of the storage and pumping facilities of the newly-expanded terminal permit it to continue to handle capacity volumes of natural gasoline while simultaneously handling increasing volumes of propane and butanes.

Since the construction of the terminal in 1933 (the modern commercial LPG industry began in 1926), the total volume of LPG produced and sold in the U. S. has soared to almost 2 billion gallins for 1947. This figure represents an increase over the preceding year of 30.3 percent. Enlarged facilities of the terminal are only a part of the industry's expansion program to meet the ever-increasing demand for LPG products. To realize the significance of the expanded terminal, the large propane tank ship, and the Newark terminal, it is necessary only to recall the domestic fuel situation in the East Coast and Middle West regions last winter. Through expanded facilities, Warren Petroleum Corporation will supply the East Coast with approximately 3 million more gallons of LPG per month than was available in that area last year.

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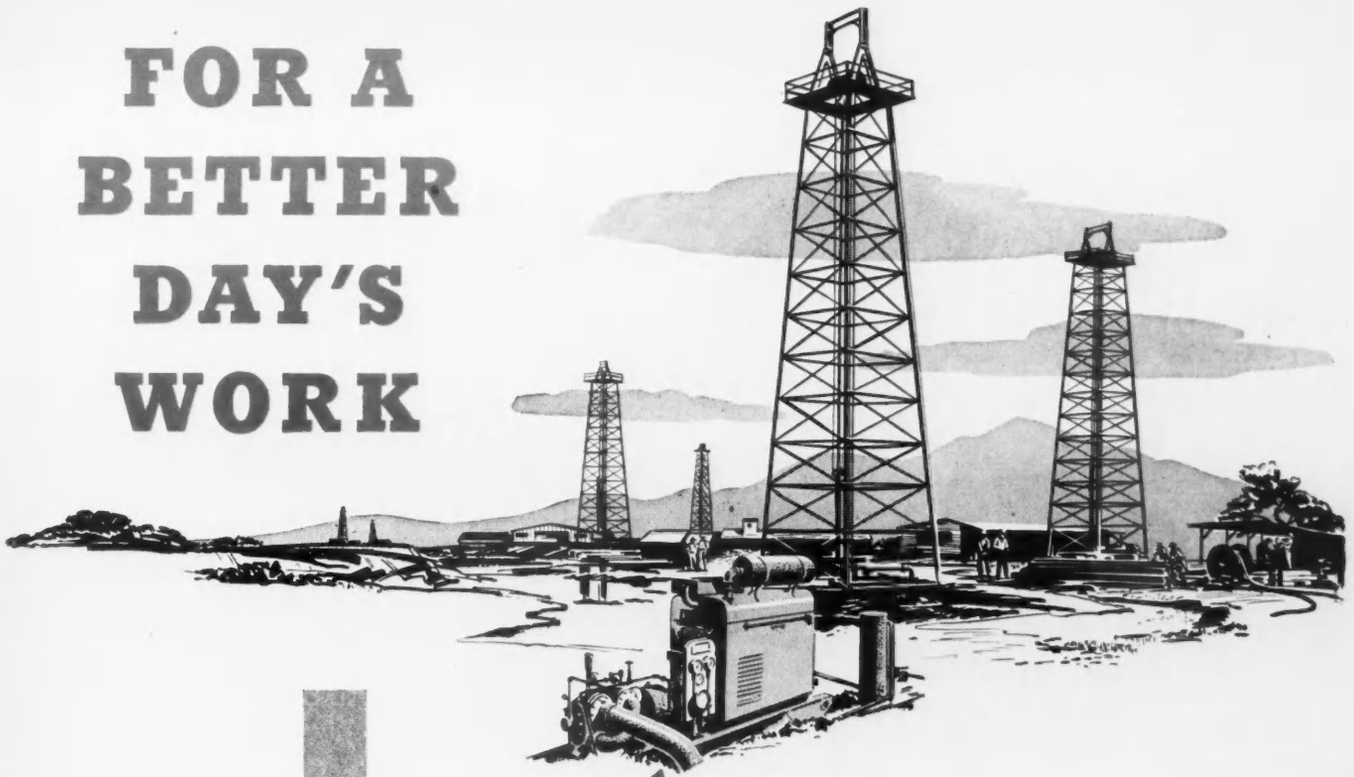

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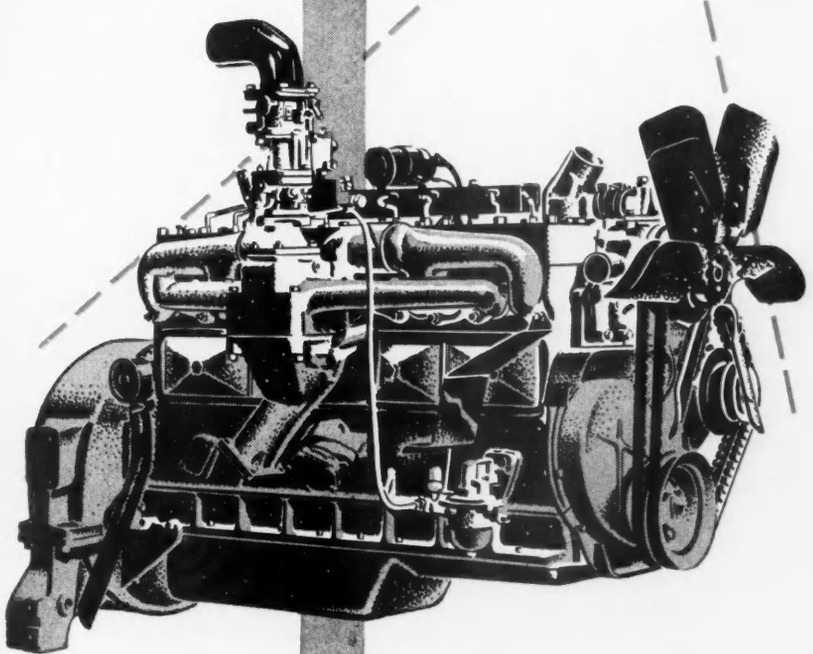

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FIGURE 1. Prior to welding, ends of six-inch aluminum pipe for Interstate Oil Pipe Line Company's experimental installation at Magnolia, Ark., were meticulously cleaned with carbon tetrachloride. Object hanging below workman's forearm is the stainless steel back-up ring used during welding to keep weld metal from forming projections inside of pipe.

Installing Test Sections of *Aluminum Pipe*

By F. E. MILLER
Interstate Oil Pipe Line Company

LAYING OF test sections of aluminum pipe in areas of high corrosion losses is developing a special technique for handling the light pipe as well as for welding it. The author describes the laying of half-mile sections while the accompanying illustrations portray the special equipment required.

THE initial installation of aluminum pipe in Interstate Oil Pipe Line Company's crude oil gathering system near Magnolia, southwest Arkansas, was successfully completed in mid-April. Construction of a second experimental line near Raceland, in coastal Louisiana, is expected to start during the second week of May.

Assisting company personnel in the construction work are technical advisors and welding experts of the Aluminum Company of America.

The construction of these two installations is part of a dual-purpose test which Interstate is conducting on aluminum as a possible material for crude oil pipe lines.

The first purpose of the experiment, to determine whether aluminum pipe welded under field conditions can withstand normal pipe line operating pressures, was the subject of tests beginning at Magnolia April 9th. On that date, the first quarter mile section of six-inch aluminum line withstood an overnight water pressure test of 1000 pounds per square inch. The second quarter-mile of six-inch and the half-mile of four-inch line subsequently laid in the same general area were similarly tested.

The second purpose is to determine the resistance of aluminum pipe to certain types of corrosion. For this reason, each of the test areas selected was one in which a particular type of corrosion is an acute pipe line operating problem.

In the Magnolia area, hydrogen sulphide laden "sour" crudes from the Dorcheat, McKamie and Macedonia pools are responsible for excessively high rates of internal corrosion. In the Raceland area, salty, acid soil conditions along the banks of the intracoastal canal cause unduly rapid external corrosion.

While the results of the corrosion studies will not be forthcoming for many months, the initial installation of aluminum pipe in the Magnolia area attracted considerable attention throughout the pipe line and related construction and service industries, and was wit-

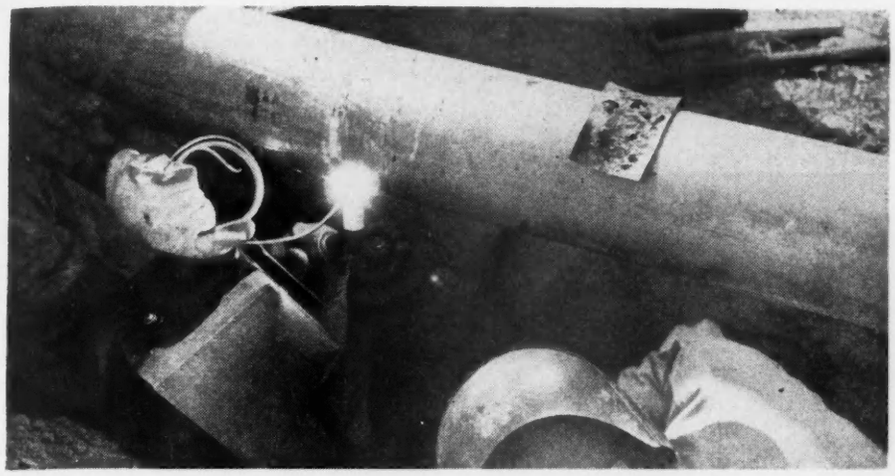

FIGURE 2. Overhead welding, aluminum line, cut time required for making a bell hole weld on 6-inch aluminum pipe to 20 minutes by the end of the second day of construction on Interstate's experimental installation near Magnolia, Arkansas. At the beginning of construction, bell hole welds were requiring 45 minutes to complete.

FIGURE 3. The filler weld has been completely made, and close observation will show that the finish weld has been made on the near side of the line. Type 43S aluminum filler rod was used to make all connections. This rod is shown rolled up in the welder's left hand. Much of the aluminum going into the weld comes from the pipe itself. Ends of pipe are beveled at the factory to 55 degrees (it was found that 30- degree bevel is satisfactory). A collapsible slip ring which can be withdrawn from the inside of the pipe is inserted at the joint before the weld is made. This procedure prevents the molten aluminum from dripping through to form icicles inside the joint. The slip ring is retracted by means of a 50-foot section of ¼-inch steel pipe which is placed in the line prior to positioning the two ends. The beveled ends of each joint are first cleaned with carbontetrachloride, then polished with steel wool. This removes any film or coating which may be present at the time of the weld.

nessed by approximately 70 outside observers.

Part of this interest can be attributed to two precedents which the Magnolia project is believed to have established. The initial section of six-inch line laid there is reportedly the first aluminum pipe to be placed in regular crude oil pipe line service, and the first aluminum line to be welded in the field by the relatively new "Heliarc" welding process.

Unusual Characteristics

Aside from the unusual number of observers, there were several characteristics which identified the Magnolia project as an innovation in pipe line construction. First, there was a marked absence of the heavy machinery usually associated with pipe line building. The 40-foot joints of 63S-T6 aluminum alloy pipe, weighing only 262 pounds, were moved into place by two men; and the line-up crew usually consisted of two men at the weld and one man at the far end of the joint. Steel pipe of the same size and length weighs 759 pounds.

To carry these weight comparisons further, the six-inch aluminum pipe used at Magnolia had the standard outside diameter of 6.625 inches, and a wall thickness of .280 inch. It weighed 6.55 pounds per foot. Steel pipe of compar-

FIGURE 4. M. R. Rivenburgh, welding engineer, Aluminum Company of America, made all the welds on the four-inch aluminum pipe line installed along the banks of the Intercoastal Canal about 23 miles from Harvey, Louisiana. Other Aluminum Company personnel aiding in this experimental project were B. J. Fletcher, chief engineer of the Development Division; E. T. Wanderer, head of Pipe & Pressure Vessel Section, Development Division; and F. N. Gordon, electrical engineer, Welding Development. Shown above is Rivenburgh putting the finishing bead on one of the joints. On this particular installation, two complete welds were made. A stringer bead is run first. Melting point of 63S-T6 aluminum, of which the line was made, was 1250° F. Heat of the arc created by 225 amps current is estimated to be about 6000° F. Such heat requires that the tip of the torch be water cooled, which is accomplished by a constant stream of water supplied by the generator engine radiator. Argon gas at the rate of ⅓ cubic foot per minute is flooded around the arc to prevent oxidation of the molten aluminum.

able dimensions weighs 18.97 pounds per foot. The 4-inch aluminum line weighed 3.73 pounds per foot as against 10.97 pounds per foot for steel.

The center of attention, however, was the welding process. In Heliarc welding, a blanket of inert gas is constantly maintained around the arc and in contact with the metal that is being welded. The purpose of the gas blanket is to prevent oxidation of the hot or molten metal. The process is named after helium, the gas originally used, but argon is now employed.

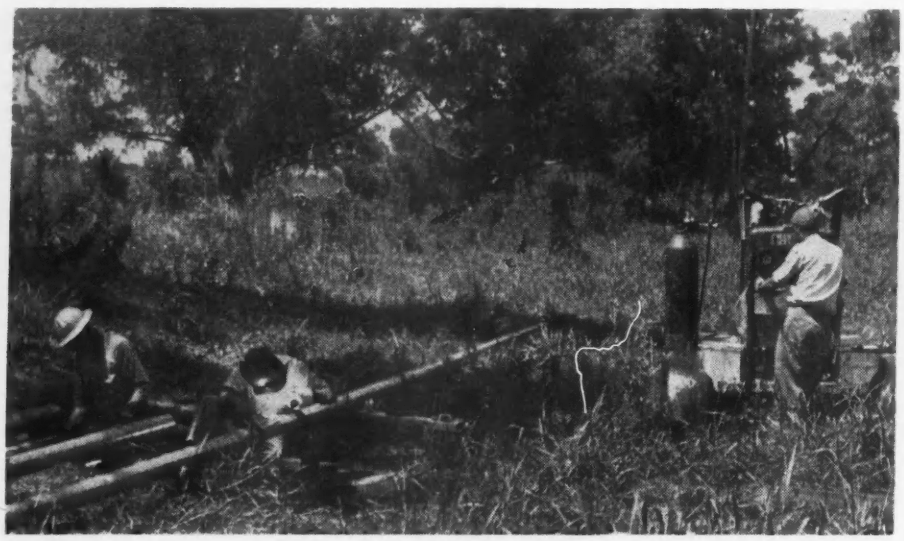

FIGURE 5. Composite view of the welding scene along the banks of the Intercoastal Canal. It is here that the external corrosive resistance of the aluminum will be tested. This terrain (Delta Farms area) is noted for its corrosive soil conditions. The electric welding generator is shown at the far right with an electrical engineer at the controls. Different types of welds were made with slightly different current settings, although the normal current flow was approximately 225 amperes. Open circuit voltage across electrodes was 90 volts. The voltage dropped to about 20 volts when arc was made. The gas cylinder on the generator unit contains argon, an inert gas which flows at 15 pounds per square inch around the tungsten electrode. From this station, two men with 48-inch pipe tongs were able to rotate the entire 2600 feet of four-inch pipe while the welder made all welds roll joints. This procedure eliminated a bell hole joint on this particular line. Every joint in the half-mile line was welded at this station without having to move the welding equipment. Lightness of the pipe (with the same dimensions as steel line pipe, this aluminum pipe is 35 percent the weight of steel pipe) permitted the line to be dragged up the right-of-way after each successive joint was made.

FIGURE 6. Dragging almost half a mile of four-inch aluminum pipe with a small side-boom cat tractor is easily accomplished as illustrated above. Boom on the cat is lowered and the winch line hooked around the flanged end of the line. With the tractor located perpendicular to the direction of pull, the line was drawn in with the winch. A two-inch test line was flanged to the four-inch aluminum pipe and, as shown above, was winched into position for connection into the test pump suction. No difficulty whatsoever was encountered in moving the 2600 feet of aluminum pipe.

The argon gas is fed into the welding zone around a water-cooled tungsten electrode. This electrode is not consumed in the arc, so weld metal in the form of almost pure aluminum wire is introduced into the arc by the welder as needed. The wire used at Magnolia was 95 percent aluminum and 5 percent silica. There was no coating of flux on the wire.

Absence of Smoke and Sparks

Because no flux is used in Heliarc welding, there was a total absence of the smoke and sparks which usually accompany arc welding operations. The resulting weld is especially neat and unmarked by splatters and slag deposits.

The chief technical difference between Heliarc and ordinary arc welding is that the Heliarc process uses alternating instead of direct current, plus a superimposed high frequency electric current. The arc is white and extremely brilliant. In fact, the arc is so bright that extra dark glass is normally used in the welders' helmets.

Two other precautions were observed by the Aluminum Company's welding crew at Magnolia. Special care was taken in cleaning the bevels with carbon tetrachloride preparatory to welding; and a wind shield was placed around the joint to prevent the blanket of argon from being blown away from the weld. The shield used at Magnolia consisted of three pieces of light plywood, notched and hinged so as to form a three-sided enclosure around the welder. A tarpaulin hung over the pipe effectively closed off the ditch under the pipe. This shield proved satisfactory for the moderate winds which pervailed during construction of the Magnolia line.

Another extra step observed at Magnolia was the insertion of a back-up ring inside of the pipe at the weld. The purpose of this ring was to prevent molten aluminum from forming projections inside the pipe.

Finally, because of the higher heat conductivity of aluminum, substantially higher welding currents were used than are normally employed in welding steel pipe of the same size. Welders at Magnolia were using 250 amperes at from 82 to 90 volts, as compared with the

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SPECIFICATIONS

"Oilwell" Rotary Drilling Unit		CT-1715C
"Oilwell" Rotary		17½-A
Speed Ratios:		
Rotary		3.28:1
Gear Box (Speed Increaser)		1:1.44
(Speed Reducer)		1.44:1
Oil Capacities:		
Rotaries	gallons	11
CT-1715A Gear Box	gallons	6
Flexible-Coupling Housing	gallons	½
Fluid Capacity of Torque Converter and Piping	gallons	9½
Fluid Capacity of Flexible Coupling (Spline Type)	pints	1
Dimensions:		
Height, Over Engine		7'4"
Height, Bottom of Skids to Top of Rotary		2'6"
Length, Overall		20'0"
Width, Overall		4'5¾"
Weight, Complete (Less Rotary Drive Bushing):		
Domestic	pounds	18,260
Export	pounds	19,660

OIL WELL SUPPLY COMPANY · USS OILWELL · UNITED STATES STEEL

Ask your nearest "Oilwell" representative for the latest Bulletin R9-1146 on Rotary Drilling Units.

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UNITED STATES STEEL

"OILWELL"

FIGURE 7. This photograph shows one of the aluminum flanges connected to a steel flange, each of series 600 and each of similar dimensions. Also illustrated is the test hookup, showing the test pressure attained, 1000 pounds per square inch. This pressure remained overnight to determine if any leakage occurred. This two-inch line connects into the discharge of the test pump. The plug valve shown immediately behind the gauge connection closed the pressure in the line. The minimum bursting pressure of each welded joint on four-inch 63S-T6 aluminum pipe is approximately 2200 pounds per square inch. While tested at 1000 pounds, this line will replace 2600 feet of the Interstate Oil Pipe Line Company's system which handles the oil from the Delta Farms and Bayou Perot fields at about 700 pounds. One 40-foot joint was flanged at both ends and inserted in the line so it could be removed for inspection at some future date. Another test procedure involved welding aluminum tabs to the pipe at the end of every sixth joint. To these aluminum tabs was attached a three-foot section of wire which will provide a means of taking electrical measurements to determine the degree of electrolysis. This line will handle about 20,000 barrels of oil per day.

200-225 amperes and materially lower voltages used in arc welding steel pipe.

Aside from the higher welding current and the added steps or precautions, the welding proceeded normally, with both rolling and bell-hole welding techniques being employed.

Reduction in Welding Time

One intersting development in welding technique was developed toward the end of construction of the six-inch line which resulted in a substantial reduction in welding time. Three rolling welds were made using a single bead instead of the two beads which were used on a majority of the welds. The time required for these single-bead welds averaged eight minutes, as compared to the 15 minutes needed to complete a two-bead weld.

The time required for completing a bell hole weld was also reduced, primarily by perfection of technique. Bell hole welds on the six-inch line requiring 45 minutes at the start of construction, were being completed in 20 minutes near the end of the second day.

The initial water pressure test which climaxed the Magnolia project was started at 3:00 p.m. on Thursday, April 8. At that time the first quarter-mile section of six-inch line was flanged off and filled with water under 1000 pounds per square inch pressure. The next morning, a group of Interstate and Alcoa personnel made a foot-by-foot surface check of the line. No leaks or "sweats" of any kind were found, and there was no appreciable loss of pressure.

Though construction of the Raceland line along the bank of the intracoastal canal will be primarily a swamp operation, the laying operations are expected to follow the pattern set at Magnolia. The major difference will be that all personnel, materials and equipment will have to be moved to the site by boat and barge.

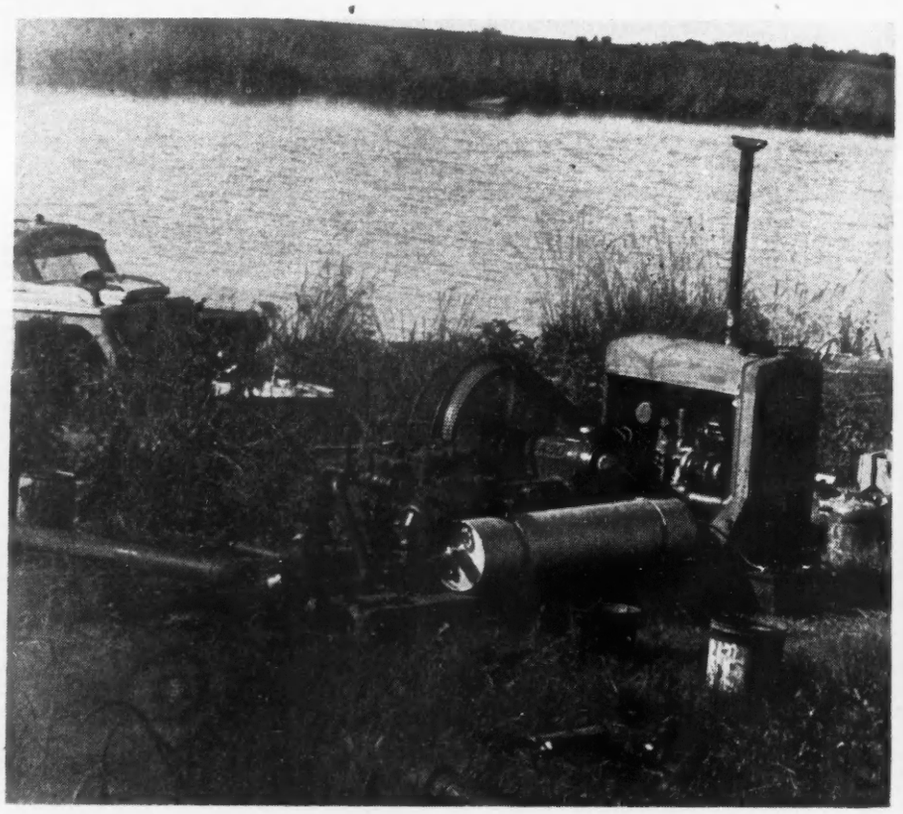
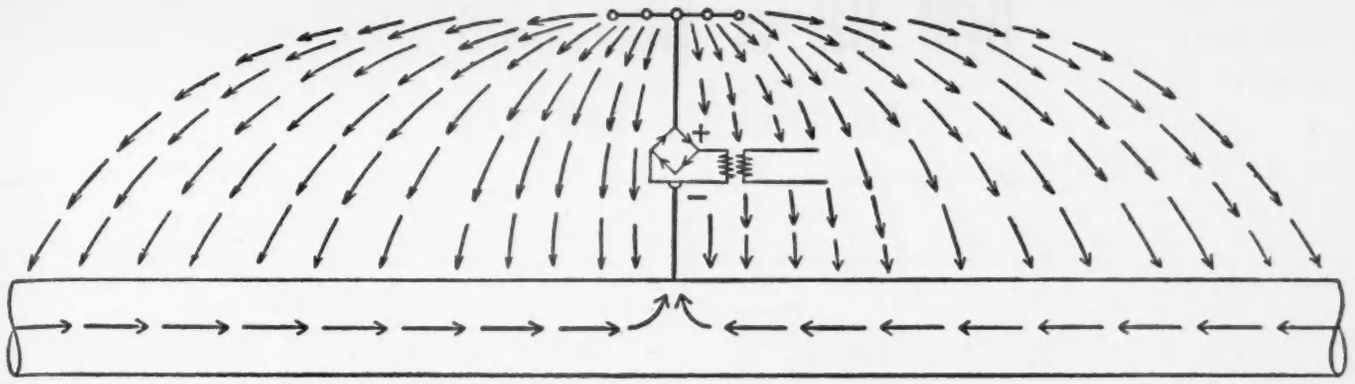


FIGURE 8. After the line had been laid, it was tested by hydrostatic pressure to 1000 pounds per square inch. This two-cylinder, duplex, gasoline engine-driven pump equipped with 2½-inch liners provided the necessary pressure. Suction of the pump was suspended in the canal, while the two-inch pressure line shown at left was connected into the end of the aluminum pipe. An hour and 15 minutes were required for the pump to fill the line. An aluminum flange, series 600, was welded on the far end of the four-inch line, and bolted to a companion steel flange. A swedge nipple, valve and pressure gauge completed the test set up. The valve remained open until the line had been purged of air.

The completion of this second installation will close the first phase of Interstate's aluminum pipe experiment. It has been demonstrated that aluminum pipe can be welded under field conditions into a pipe line that will withstand normal operating pressures.

The second phase, that of determining whether aluminum's theoretically higher resistance to certain types of corrosion will prove superior enough to offset the higher initial cost, will then be given consideration.



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Mechanically applied by modern methods, these coal-tar enamels assure the proper continuity of the insulation.

Electrical inspection improves the quality of application and the handling of pipe during construction and, together with a protective pipe coating of stable dielectric strength, makes cathodic protection economical. This combination permits the use of a minimum number of cathodic protection units, spaced the maximum distance, and a minimum investment in the complementary electrical protection. A dependable procedure when designing corrosion-proof pipelines.

FIELD SERVICE: The Barrett Pipeline Service Department and staff of Field Service men are equipped to provide both technical and on-the-job assistance in the use of Barrett* Enamel.

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Pipe Lines of the U. S.

Bell Oil & Gas Company
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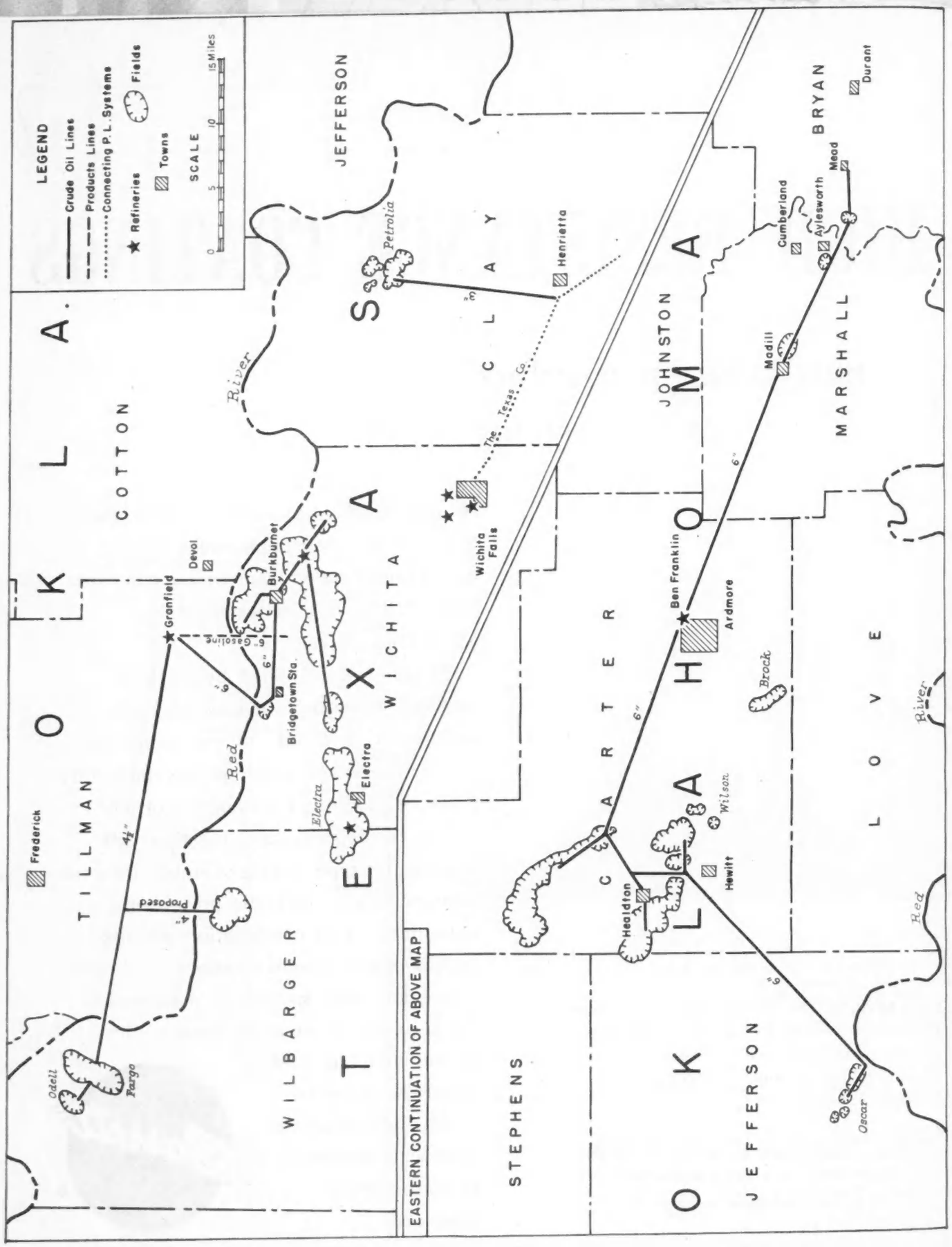
52nd of a Series



PIPE LINE *Construction*

WITH FPC ratification of Trans-Continental Gas Pipe Line Company's application to build an approximately 1840-mile 26-inch line from Texas' Rio Grande Valley to New York, need for additional pipe for both cross-continent natural gas and crude oil lines was underlined by FPC and eight state regulatory commissions in the Midwest and Appalachian area. The commission asked the Steel Advisory Council to take steps to assure steel for natural gas lines under the voluntary steel allocation program because of the shortage of gas supplies in many states last winter. A recent report by Bruce C. Clary, president of Stanolind Pipe Line Company, estimates that pipe for 17,219 miles of petroleum lines will be required between April 1, 1948, and October 1, 1949. The Gas Appliance Manufacturers Association estimates the requirements for proposed utility gas lines and the requisite trunk lines to supply those systems at approximately 20,992 miles.

FPC also approved the application of Alabama-Tennessee Natural Gas Company to build in northern Alabama and northern Mississippi approximately 136 miles of line plus laterals, carrying some 30 million cubic feet of gas daily.

Construction on the Michigan-Wisconsin Pipe Line Company's project to take Texas Panhandle gas to Detroit has been resumed after being shut down for a time by litigation with Panhandle Eastern Pipe Line Company.

FPC will begin hearings on another long gas transmission line, Trunkline Gas Supply Company's 855-mile 30-inch line from Texas Gulf Coast to Iowa.

Meanwhile, the longest big-inch crude oil carrier constructed since the war, Magnolia Pipe Line Company's 650-mile 20-inch line from Corsicana, Texas, to Patoka, Illinois, was put into operation. The new line will pump a volume of 100,000 barrels of oil a day under an average pressure of approximately 700 pounds per square inch. The line connects the company's system in Texas and Oklahoma with its Great Lakes network in Illinois, Indiana, and Ohio, supplying areas where oil is badly needed and where shortages developed during 1947.

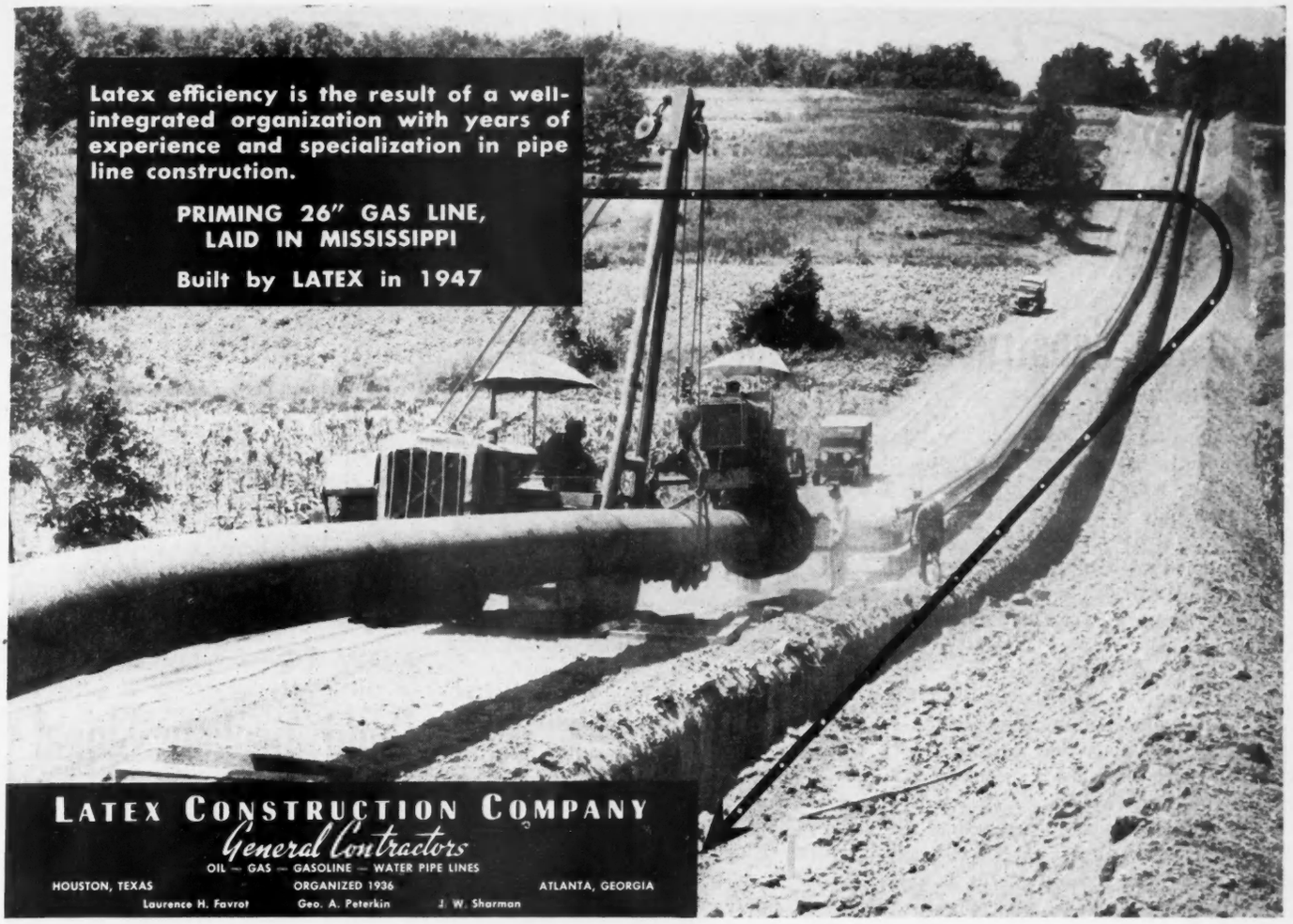
Another of the long crude oil pipe line projects is nearing completion of the second of its three spreads. The Basin Pipe Line System being built by The Texas Pipe Line Company, Shell Pipe Line Corporation, Sinclair Refining Company, and Empire Pipe Line Company is expected soon to be complete from Jal, N. M., to Wichita Falls in North Texas

Pipe Line Construction Activity

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Inches)	Daily Capacity (Bbls., Cu. Ft.)	REMARKS
CRUDE OIL LINES					
Anglo-Iranian Oil Co., Ltd.	Agha Jari field to Abadan refinery, Iran	56 25	20-22 8-10	100,000	Construction to start as soon as license to export pipe can be obtained in U. S.
Buckeye Pipe Line Co.	Fostoria to vicinity of Cleveland, Ohio	124	12	.....	H. C. Price Co., Bartlesville, Okla., contractor.
The California Co.	Rangely, Col., field gathering system	60	4-20	.....	Work under way by L. E. Farley, Houston; scheduled to complete in Sept.
Corporación de Fomento de la Producción	Cerro Manantiales (Spring Hill) field to proposed marine terminal, Chile	50	.....	.....	Route and plans being considered.
Gulf Refining Co., Houston Pipe Line Division	Chester station and Sour Lake station loop, Upper Texas Coast	15	12¾	.....	Work started late June by Carl H. Dunn, Ft. Worth; completing in July.
Humble Pipe Line Co.	Ector and Judkins stations, West Texas	13	6	.....	Takeup job completed by Permian Basin Construction Co., Odessa, Texas. New line laid early in year: 10⅝ miles of 8-inch.
	Talco field gathering lines, East Texas	11	8	.....	Reconditioning of line to be completed in July.
Magnolia Pipe Line Co.	Corsicana, East Texas, to Patoka, Ill.	650	20	100,000	Completed. First delivery of oil on June 2. H. C. Price, Bartlesville, Okla., and Oklahoma Contracting Co., Dallas, built line.
	Premont field gathering lines, Southwest Texas	2⅝	8	.....	Shanks and Eustace, Alice, Texas, completed project.
	Shawnee to Chandler, Okla.	26	8	.....	Line being reclaimed by Bishop & Lock Construction Co., Dallas; completing mid-July.
Pan American Pipe Line Co.	Arroyo Colorado River crossing, Willacy County, Southwest Texas	.....	8	.....	Reconstruction completed by Altgelt Construction Co., Corpus Christi, Texas; Witchita Falls, Texas.
Phillips Petroleum Co.	Odessa, West Texas, to Phillips' refinery, Texas Panhandle.	315	12	.....	Plans announced by company.
	Near Borger, Texas Panhandle	5	3	.....	Vaughan & Taylor completing takeup job.
Salt Lake Pipe Line Co.	Rangely, Col.	.....	.....	.....	Contract for two stations on Rangely to Salt Lake City line awarded to Brown Lane Co., Palo Alto, Calif.
	Hanna, Utah	.....	.....	.....	
Shell Pipe Line Corp. and The Texas Pipe Line Co.	Cushing Okla., to Wood River and Salem, Ill.	497	22	200,000	Ozark Pipe Line System project due to get under way in October, complete April, 1949.
Stanolind Pipe Line Co.	Near Dallas City, Ill.	41	8 & 10	.....	Takeup and recondition job handled by Trojan Construction Co., Oklahoma City.
	Lost Cabin to Arminto, Wyo.	22	12	.....	Pacific Pipeline & Engineers, Ltd., Los Angeles, completed late June.
	Slaughter-Drumright river crossing. (Salt Fork of Red River crossing and Prairie Dog Town Fork of Red River crossing)	1⅛	16	.....	R. H. Fulton & Co., Lubbock, Texas, has work under way, to complete end of August.
	North Fork of Red River crossing and South Canadian River crossing	1¾	16	.....	Contract to be awarded, work completed by October 15.
Southwest Texas Pipe Line Co.	Sinclair Damon station to Phillips' Alamo refinery, Southwest Texas	14	6	10,000	Brown & Root, Houston, completing project.
The Texas Pipe Line Co., Shell Pipe Line Corp., Sinclair Refining Co., and Empire Pipe line Co.	Midland, West Texas, to Wichita Falls, North Texas	253	22	70,000	Second section of Jal-Cushing line due to complete early July, Latex Construction Co., Houston, contractor.
	Jal, N.M.	.....	.....	.....	Station to be constructed on Jal-Cushing line by Brown Lane Co., Amarillo, Texas.

Pipe Line Construction Activity—Continued

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Inches)	Daily Capacity (Bbls., Cu. Ft.)	REMARKS
PRODUCTS LINES					
Sinclair Refining Co.	Houston, Upper Texas Coast, to Arlington, North Texas, with laterals to Dallas and Ft. Worth	264	10	25,000	Line completed by H. C. Price Co., Bartlesville, Okla. Extension of line 177 miles to Panova, Okla., under way by Pacific Pipeline & Engineers. Crude lines to Great Lakes being reconditioned and converted to complete system.
Socony-Vacuum Oil Co.	Malvern, Pa., to Binghamton, N. Y.	155	8	18,000	Construction under way by Midwestern Constructors Tulsa. Completion scheduled December.
Standard Oil Co. (Indiana)	Terminal station at Cape Girardeau, Mo.	2½	3-12	.....	To be completed late September by Midwestern Contractors, Chicago.
	Terminal station at Peoria, Ill.	5	3-12	.....	Completed by Midwestern Contractors.
NATURAL GAS LINES					
Alabama-Tennessee Natural Gas Co.	From TGT line near Selmer, Tenn., to Tuscumbia, Ala.	75	10	30 mln	Approved by FPC. Application includes laterals to Corinth and Iuka, Miss., and Florence, Sheffield, Tuscumbia, Muscle Shoals, Athens and Hartselle, Ala.
	Tuscumbia to Huntsville, Ala.	61	6		
Arkansas Louisiana Gas Co.	Mayfield gasoline plant to Columbia gas treating plant, Ark.	11 3/10	6	4 mln	Snelling Company, Shreveport, La., completing early July Construction being done by company personnel.
	Haynesville field to Columbia gas treating plant, Ark.	16	6	}	
		1 3/10	4½	20 mln	
Cities Service Gas Co.	Lyons, Kans., compressor station	.....	.....	.....	Company crews installing two 170-HP booster engines, increasing capacity to 900 HP.
	Two miles east of Ellsworth, Kans.	.....	.....	.....	New station to be built.
El Paso Natural Gas Co.	Plymouth and Slick-Urschel discovery, Upton County, West Texas, to Jal, N. M.	110	20 or 24	25 mln	Line to be built by company crews, completed within 18 months from May, 1948.
Home Gas Co.	Horseheads to Dundee, N. Y.	25	10		
		10	4, 6, 12	.....	Contract awarded to Britton Contracting Co., Ft. Worth Starting August.
	Hancock to Cocheeton, N. Y.	30	12	.....	Contract awarded to Britton Contracting Co., starting July.
	Dundee field, Watkins Glen, N. Y.	.....	.....	.....	1400-HP station to be built in July.
Houston Pipe Line Co.	Guy to point near Wharton, Upper Texas Coast	12	12	.....	Takeup and salvage job completed by J. R. Stewart Co. Houston.
		5	18		
Independent Natural Gas Co.	Alvin area, Upper Texas Coast	5	6	.....	Completed by Association Contractors & Engineers, Houston.
	Blue Lake Field, Brazoria County, to Alamo Oil Co.'s Sweeny refinery, Upper Texas Coast	17½	8	}	Completed by Associated Contractors & Engineers Houston.
		3¾	6	30 mln	
		1½	4	}	
Lone Star Gas Co.	Opelika field, Henderson County, East Texas, to Dallas	100	20	.....	Permission to build asked of FPC.
	Fox Central compressor station, Carter County, Okla.	.....	.....	.....	2400-HP units to be installed if FPC approval granted.
	Stations in Cook, Knox and Grayson counties, Texas	.....	.....	.....	3620-HP units to be installed if FPC approves.
Michigan-Wisconsin Pipe Line Co.	Hansford County, Texas Panhandle, to Austin field, Mich., and Green Bay, Wisc.	1181	24, 22, 18	325 mln	First spread of 225 24-inch miles shut down after 40 miles completed by J. R. Horrigan Construction Co., Houston. Work resumed and spread extended to 450 miles.
Mississippi River Fuel Corp.	Loops on line from Monroe gas field, La., to St. Louis	100	22	.....	Spread completed by R. B. Potashnick, Cape Girardeau, Mo.
Northern Natural Gas Co.	Point northwest to Sublette compressor station, Kans.	14	20	.....	Work under way by R. H. Fulton & Co., Lubbock, Texas, on 20-inch; 16-inch to start in September.
		12½	16		
	Just east of Sublette, Kans.	19	8	.....	Work starting in July. Brodie Construction Co., Hugoton, Kans., contractor.
		17	8		Takeup and relay job awarded to Brodie.
Northern Oklahoma Gas Co.	Perry to Otoe field, Okla.	7	4	2 mln	Wilson Construction Co., Tulsa, starting job.
Oklahoma Natural Gas Co.	Near Wewoka to Velma pool, Stephens County, Okla.	66	16	} 80 mln	Contract awarded to Trojan Construction Co., Oklahoma City. Work starting August 1.
		67	12		
Ohio Fuel Gas Co.	Near Sugar Grove, Ohio	40	20	.....	Midwestern Constructors, Tulsa, laying 20-inch, taking up rest (all line R-501); to complete end of September.
		97	16, 12, 10, 8, 6, 4		
	Treat compressor station and connection with West Ohio Gas Co. in Allen County, Ohio	97	.....	.....	Authorized by FPC.
	Pavonia station to connection in Crawford County, Ohio	21	20	.....	Application filed with FPC.
	From line in Seneca County to point near Lime City in Wood County at Toledo connection, Ohio	40	20		
Southern Union Gas Co.	Loop on San Juan Basin-Albuquerque N. M. line	38	12	.....	Work under way by Delmar Spafford, Farmington, N.M.
Tennessee Gas Transmission Co.	From Main Line Valve No. 60, Panola County, to MLV 65, Miss.	45	26	.....	Contract for looping awarded to H. C. Price and Co., Bartlesville, Okla.
	From MLV 55, Washington County, to point near Greenville, Miss.	15	26		
	From west side Mississippi River to MLV 53, Chicot County, Ark.	10	26		
	From Station 14, near Catlettsburg, Ky., to Cornwell station, W. Va.	89	24	.....	Contract awarded to Oklahoma Contracting Co., Dallas.
	From MLV 46, south of Monroe, La., to MLV 42, Winn Parish, La.	45	26	.....	Work under way by company crews.
	From MLV 94, Green County, to MLV 101, Boyle County, Ky.	63	26	.....	Completed by Anderson Brothers Construction Co., Houston.
Texas Eastern Transmission Corp.	Philadelphia, Pa.	20 3/5	12	.....	Brown & Root, Houston awarded contract. Midwestern Constructors, Tulsa, subcontractor. Work to be completed mid-July.
		6	8		
		1	6		
	From main line in Harris County to Stanolind's plant in Hastings field, Upper Texas Coast	20	8	.....	Construction approved by FPC. Application includes changes in compressor stations, installation of additional horsepower.
	From Little Big Inch to California Co.'s Southwest Gas Producing Co.'s plants in Hico-Knowles field, La.	5	10		
		2	10		
	From Little Big Inch to Silsbee field, Upper Texas Coast	17 1/5	10		
Trans-Continental Gas Pipe Line Co.	From the Lower Texas Coast area to New York City	1840	.....	340 mln	Application approved by FPC includes 15 compressor stations; scheduled to be ready for operation in fall of 1950.
United Gas Pipe Line Co.	Point near Jackson to point near Yazoo City, Miss.	32	18	.....	Takeup job completed by L. E. Farley, Houston.
U.S.S.R. Government	Kohtla-Jarvi shale mines, Esthonian Republic, to Leningrad, U.S.S.R.	125	.....	.....	Government reported building line for completion in summer, 1948.
Western United Gas & Electric Co.	Compressor station at Elgin, Ill.	1 1/5	1-12	.....	Midwestern Contractors, Chicago, completed.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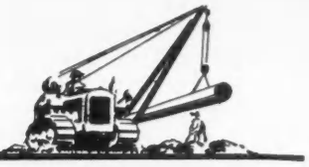
PIPE LINE HINTS

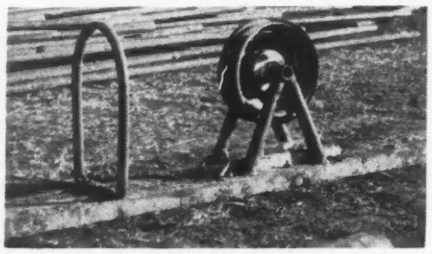


$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Construct Device for Straightening Small Diameter Pipe

In salvaging small diameter line pipe, it frequently is the case that many of the joints will be bent slightly. If a hydraulic pipe straightener is not available, many of the crooks can be straightened with a simple device such as that illustrated. This device was constructed from a discarded automobile wheel, a pair of pipe flanges, a few short lengths of 1¼-inch pipe, some two-inch angle iron, and a few bolts.

The two pipe flanges were drilled so that the holes lined up with the holes in the wheel hub. Short pieces of one-inch pipe were welded to the neck of each flange to form a supporting axle for the wheel. Bearings for the axle were made from short pieces of 1¼-inch pipe mounted on top of two A-frames also made from 1¼-inch pipe. Two-inch angle iron formed a base for

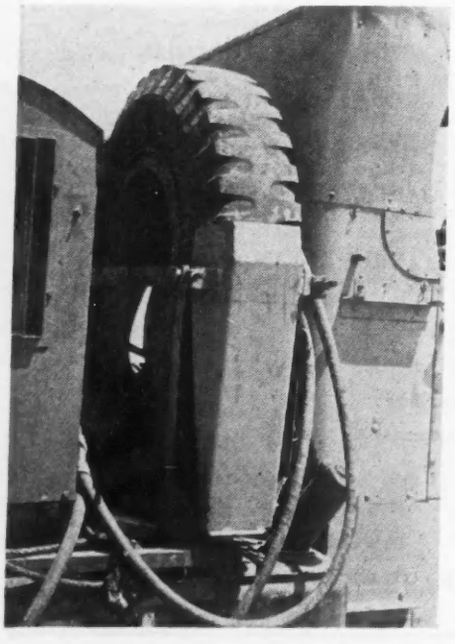


the frame and provided a means of anchoring the wheel assembly to a long 2x12-inch timber.

A piece of 1¼-inch pipe flattened on each end and bent at right angles to the pipe was bent into a loop as shown. Holes drilled in these flat ends made it possible to bolt the loop to the 2x12. In straightening a piece of bent pipe, one end of the pipe joint is placed under the loop, while the bend is placed over the wheel, providing considerable leverage with which to rebend the pipe. One man usually can correct bends in pipe up to two-inch, but two men may be required for larger pipe.

HOW TO—Simplify Handling of Spare Tire

The problem of handling the large mounted truck tires on pipe line welding trucks when a change has to be made on the road or in the field frequently assumes major proportions, particularly if man power is limited at the time. One company employs a unique spare tire carrier which is set up directly behind the cab of their welding unit. Instead of relying on special brackets requiring accurate alignment or positioning of the tire, and which sometimes require that the tire be lifted a short distance to get it into its position, a collapsible mounting, as shown, is employed.

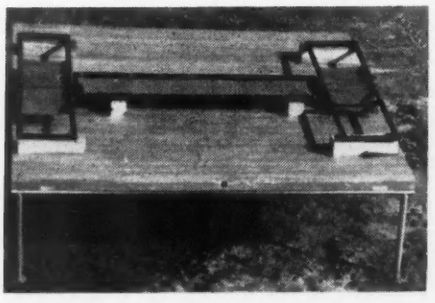


Made of heavy gauge sheet steel, the side of the carrier is hinged, this section being dropped down to provide a small ramp over which the tire can be rolled either up or down. When the spare is replaced in its position, nuts on the long threaded bolts on either side of the rack are drawn up tightly, squeezing the tread and preventing any movement or chafing of the tire when the truck is in motion.

HOW TO—Build Airplane Signal

When walking-the-pipe-line gave way to flying-the-pipe-line, there arose the problem of communications. Often it was necessary to instruct the pilot to land, turn back, etc. One pipe line transmission company installed airplane signals at various points along the line for this purpose.

A 20-foot square table was constructed of light pipe frame and wooden decking painted white to contrast with the ground. Three 2x15-foot rectangular frames of 1¼-inch pipe were suspended two inches above the table top to form a large "H." Orange-painted canvas duck cut to fit the inside of the frames was attached to the long side of the rectangles with light metal clips. The clips were free to slide along the pipe

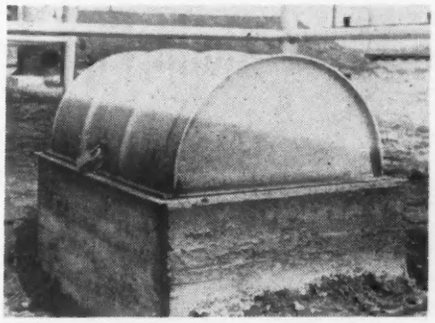


permitting the canvas to be stretched the full 15-feet of the frame or to be bunched at one point.

The letters "I," "H," "L," and "T" could be formed or orange canvas against the contrasting background of the table permitting four different messages to be given the pilot.

HOW TO—Construct Cover to Protect Valves

Where valves on vent lines are subject to tampering, a simple cover which will also protect the valves from the weather may be made from a 55-gallon drum. The usual concrete box is made around the valves with a three-eighths-inch by two-inch plate grouted into the top of the walls. A 55-gallon drum is then cut in half through its vertical circumference with a welding torch. A three-eighths-inch by one-inch plate is welded to the edge of the half of the drum to make a smooth, flat surface. The other half of the drum may be fabricated in the same manner so that one drum will supply material for two covers.

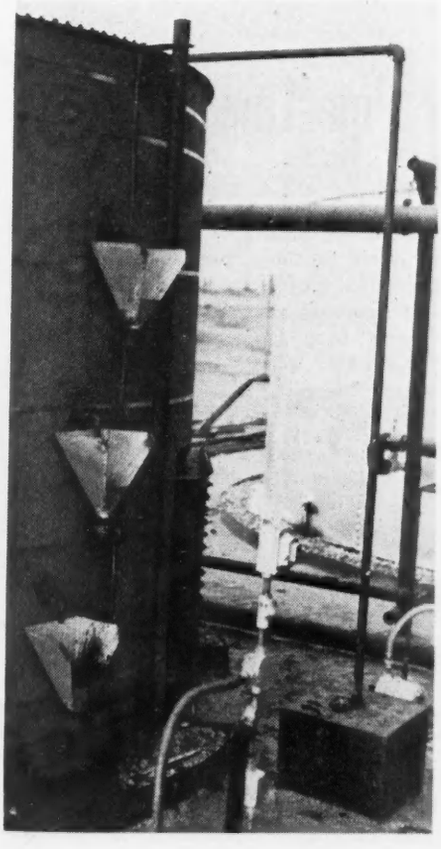


Hinges are welded to one side of the drum half and the staple for the lock to the other. The strip of metal around the top of the concrete box serves as an attachment for the other part of the hinges and the lock assembly. A master lock is used so that only authorized persons will have access to these valves.

HOW TO—Drain Oil Splashes at Bleeder Cocks

Installation of bleeder cocks and drainage system on the side of a small insulated oil tank in such a way as to minimize and confine splashing of oil down the side of the tank and over surrounding ground was accomplished in a neat manner at one pipe line station.

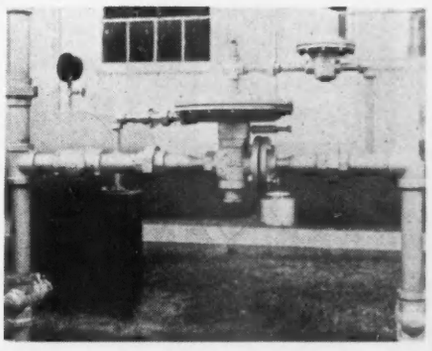
From a two-inch riser, the latter extending to the top of the tank and open at the top, were brought out horizontal nipples fitted with tees and rectangular funnel shaped splash troughs. These collecting pans, made of galvanized sheet metal, fit up closely to the bleeder cocks and are open at the front to permit the gauger to insert and fill his sample cans. Waste oil drains into the riser and on down into a common waste oil collecting system common to the adjacent tank battery. The system is built flexibly, the individual horizontal drains being swung out whenever necessary for cleaning or repair. It contributes much to the general cleanliness and reduced fire hazard at the tank battery installations.



HOW TO—Regulate Pressure Load

The diaphragm of weight-loaded pressure regulators may be loaded by pressure to replace the lever and weights by a unique system which employs a second regulator. Downstream side of the regulator shown is to the left, where a half-inch line with a needle valve is connected to the bottom of the diphragm chamber. When the pressure is equal to the weight of the diaphragm plates, the valve assembly and the pressure applied on top, the shaft of the valve will move downward and the valve will close.

Pressure on top of the regulator diaphragm is supplied by a small reducing regulator which is connected to the high-pressure side of the main regulator. It drops the pressure down to the desired value by means of a small spring-loaded diaphragm. By using a small constant bleed cock, shown above the cross on top of the main regulator, a constant pressure is maintained on the upper side of the diaphragm. If it is necessary to change the outlet pressure of the main regulator, the set screw which controls the spring tension on the small regulator is moved up or down the required amount.



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HOW TO—Build Pipe Line Cross-Over Bridge

Around compressor stations, pumping stations, and pipe line terminals, it is usually necessary to provide walkways or cross-over bridges over large diameter pipe lines which are located above ground level. The type of cross-over bridge illustrated was standardized and made in quantities which considerably lowered the cost.

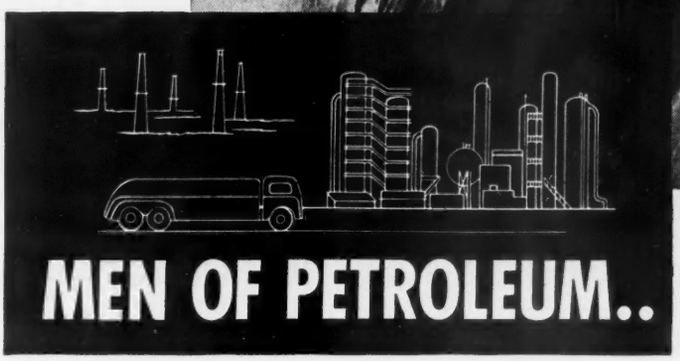
On either side of the pipe line was set concrete steps of sufficient height to clear the highest elevated line around the station. These steps can be prefabricated in one shop to facilitate mixing and pouring the cement. The metal bridge was also fabricated in the shop and in sufficient numbers made to fill all requirements around the station.

The handrail and supports were made from one-inch piping. A piece of angle iron was set in the concrete across the upper edge when the form was poured. The metal bridge was tack-welded to the angle iron piece which held it in place. Longitudinal strips of metal welded so their edges face upward formed the footing surfaces.

HOW TO—Compensate for Pipe Line Expansion

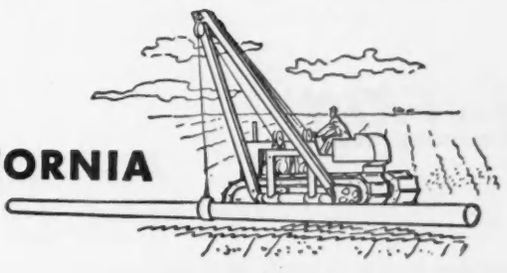
In a pressure maintenance project operated by a major producer, expansion and contraction of pipe lines under wide temperature range of the atmosphere, and the top soil, encountered extreme stresses in the smaller lines which were overcome by inserting a large diameter loop standing upright in the air. Where the pipe raises from the ditch, there is a narrow and quite long concrete lined trench in which heavy duty pipe line flanges are placed that connect the expansion loop to the pipe line.

So that the loop will remain upright, guy lines are attached to the top of the wide bend and anchored to posts set several feet distant. Tension on the guy lines is maintained with standard turnbuckles, one on either side of the expansion loop. The open concrete ditch is supplied with removable steel covers made in sections to provide maximum convenience for men in the pipe line and repressuring crew. The pipe is free to move in the ground, not being anchored at any point, but all expansion and contraction are absorbed by the "aerial" loop.



MEN OF PETROLEUM..

PIPE LINE MAN... A hundred thousand barrels of black crude, pumped from the oil fields to refineries or tanker ports, flow through this pipe daily. Sometimes the pipe is carrying natural gas, sometimes it carries refined products to storage tanks or shipping docks. The pipe line man makes sure it's doing its job right. Here he's checking welds on one of our lines that's 176 miles long. He's taking gamma-ray pictures of a weld, looking for defects. In the office, telemeters can give him flow readings at a point nearly two hundred miles away, help him watch the progress of precious petroleum on its way to people and industry.



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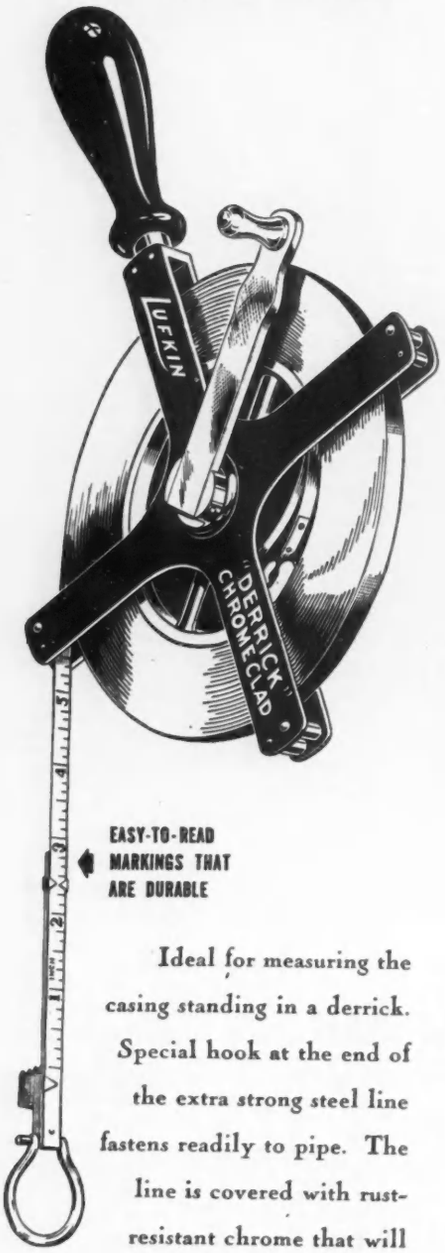

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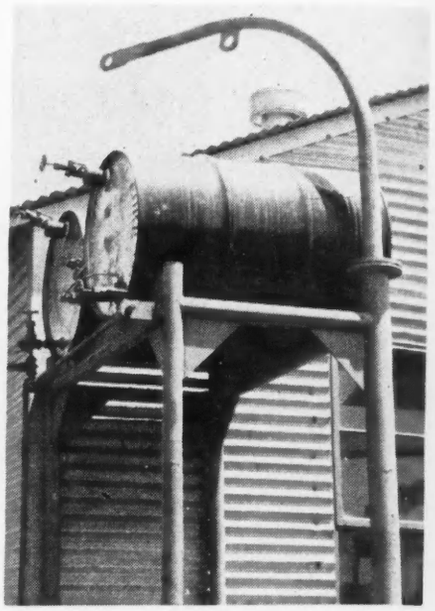
HOW TO—Mount Chemical Drums for Gravity Flow

To provide a constant and full flow of cleaning solvent for the tester in the pipe line lab, drums of solvent may be placed on a supporting platform outside the building, high enough that the material can be drawn from the containers by opening a spigot over the sink when cleaning centrifuge and testing glassware.

Full drums of solvent are equipped with fittings in the small bung hole which in turn have connections for attaching copper tubing leading to a manifold and the supply line entering the pipe line laboratory. A davit is placed on one supporting post of the platform so that a small hand winch may be used for raising the container and setting it in the cradle before making the outlet connections.

The supporting platform is made from 2½-inch pipe while the supporting corner post in which the davit is fitted is three-inch pipe. Top of this leg is flanged so that full throat opening of the three-inch pipe is provided. A similar flange is welded around the 2½-inch pipe so that several feet extend into the three-inch leg, thereby providing adequate support for the davit as well as making it possible to rotate the davit through 360 degrees. Since these chemicals last for several weeks, it is well worth the extra time it requires to lift them on top of this platform for the convenience which results.



HOW TO—Install Working Tools on Welding Truck

The operator using a welding truck frequently finds it necessary to shape light metal, straighten rods or form metal, which may be done more easily when an anvil is available. One company places a flat bar of 1½-inch steel on the corner of the truck bed so that these operations can be done at any time. This bar of steel is approximately eight inches by 12 inches, smooth on top, and welded to the skid-proof floor of the truck.

At the same time, the welder may require the use of a pipe vise, and to hold material solidly and firmly in position, a steady-rest is placed on the bed of the truck perhaps a foot inward from the pipe vise. This rest is in the form of a "V" block, mounted on a heavy threaded stem which may be adjusted, up or down, in a large nut welded to the bed of the truck.

The operator of this truck has also added a convenient means for climbing upon the bed of the truck. A vertical rung made from salvaged three-fourths-inch sucker rod was welded to the wide protection plate on the rear of the truck. On the surface of the truck bed, a hand rung was welded of the same material. With the aid of these two devices, the welder or helper can easily and safely get aboard the truck.

POSTWAR PROGRESS IN CHINA'S NORTHWESTERN OIL FIELD

By K. C. LU

OIL prospecting in the Laochunmiao (Old Man's Temple) field of Northwestern China in the Gobi desert, Kansu Province, was started about ten years ago and to date a total of 34 wells have been drilled, 19 of which are flowing wells. The field is producing approximately 2000 barrels per day, which is being refined at the Chinese Petroleum Corporation's modern refinery. Evidence of the productivity of the sands is that no dry hole has been drilled on the structure known as the Kunghsingshan Anticline.

Results achieved during the past ten years can be seen as one enters the main gate of the Laochunmiao field characterized by the four giant pillars which dominate the desert landscape. Here are the lofty towers of the refinery, the tank farms, derricks, pipe lines, modern offices and houses for personnel, the big machine shop, electric power station, and the commissary buildings.

One of the disadvantages encountered by workers in the Laochunmiao field is the rigorous climate of the region, where temperatures during five long winter months average about four degrees below zero Fahrenheit. However, the climate is dry and fresh snows assure an abundant supply of water.

As in other oil areas throughout the world, development of the Laochunmiao field has been retarded due to shortages of material, both drilling equipment and tubular goods, which impede the working out of an orderly program. More than two years after the war China's petroleum industry appears to be in worse shape than during the conflict, when every effort was made to produce as much crude and refined products as possible. Factors outside the industry are responsible for the situation as the industry itself is increasing production, although not in sufficient quantities to meet the country's growing demand.

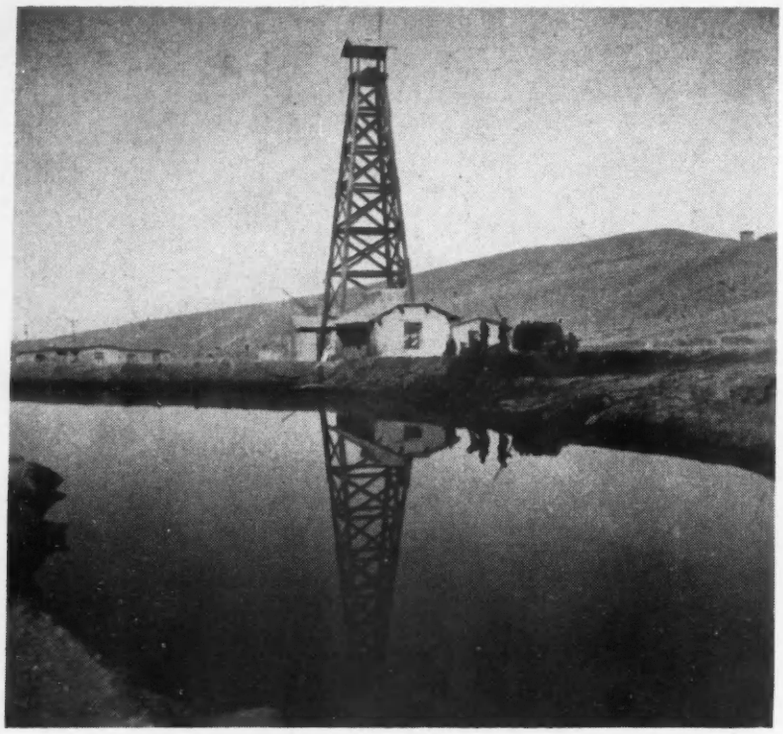
Development of Laochunmiao Field

Work was begun in the Laochunmiao field in the spring of 1939. The discovery well, drilled with cable tools, was completed at approximately 420 feet, topping the "K" sand, as a small pumper. Six

Above picture shows surface structure of the anticline which is called the Kunghsinghan. Left to right, south flank to north flank.

About the Author

ENGINEER K. C. LU typifies the new spirit of China which is driving its young men along the path of industrial progress. Graduating in 1933 with a B.S. degree in engineering, he worked several years in the coal regions of Kansu Province. In 1940 he became interested in his country's oil possibilities and joined the Kansu Petroleum Administration, later gaining experience with a Shell Oil Company unit. He is now petroleum engineer for the Chinese Petroleum Corporation and believes his country is destined to become an important oil producer.



Old cable tool derrick reflected in the crude oil storage which was a natural open pool in 1941

other shallow wells were completed in 1940 and 1941.

The first attempt to tap deeper production was successful when the No. 4 well was drilled in 1941 to approximately 1350 feet, topping the prolific "L" sands. However, the well came in out of control and caught fire after producing an undetermined amount of oil. Three additional wells drilled to the same pay also blew out and later bridged over after producing an estimated 700,000 barrels, some of which was impounded in an earthen storage pit.

Two small rotaries were introduced in 1943, as well as additional facilities and at the end of 1947 a total of 20 wells drilled to the deeper horizon or "L" sands had up to the end of last year, produced almost 3 million barrels of crude.

The field is on a high plateau varying from 7800 to 8500 feet in elevation, making the building of roads and construction of houses and rig sites extremely difficult due to inadequate transportation facilities. The main supply centers are from 75 to 400 miles distant in Chiuchuan and Lanchow and supplies are hauled over the Old Silk Highway, the only main road in that part of the country. Into this area it was necessary to transport equipment and materials and all supplies at the rate of 3000 tons per month. Staff members and workmen totaling about 5000 persons had to be housed and fed.

Several pay zones have been found within the Kunghsingshan Anticline, which is considered the highest developed oil field, from point of elevation, in the world, being from 500 to 1000 feet higher than the Wilson Creek field in Colorado. Oil seepages are to be seen in many parts of the anticline.

Oil Occurrence

The Shih-You-Ho (Rock Oil River) cuts through the center of the Laochunmiao field which apparently accounts for the seeps, the largest of which is located in the Kanyouchuan, or Dry Oil Spring, close to the axis of the structure.

A surface study of the field provides good evidence that the source of the oil is the sediments of the Upper Paleozoic, Lower Mesozoic and probably the Carboniferous. According to some geologists, the Permian beds are continental in origin as are the Triassic, Jurassic, and the Cretaceous. The lower Carboniferous beds rest unconformably on the metamorphic rocks of the Chilian mountain series and seem to be lower Paleozoic in age.

In view of the nature of the Laochunmiao field structure as an asymmetrical advance fold in front of the northward overthrust Chilian mountain range, it is believed that the entire advance belt of the structure represents an incipient thrust in advance of the main range and that the oil originated in the Carboniferous rocks deep under the Chilian mountain front and migrated up into the Tertiary rocks along the fractured belt of the thrust plane, which almost certainly would be found to be a definite fault in the deeper rocks.

Late Tertiary or early Quaternary rocks are gravels and sandy gravels of great thickness that have suffered much of the deformation that produced the anticline and now stand with dips as high as 80 degrees. The principal formation penetrated is the Red Beds of Tertiary age which outcrop at several points on the structure. A feature of the anticline is the white and light yellow sandstones which form conspicuous markers in the field. Just below the Red Beds is a zone of dark chocolate colored shales followed by gypsum beds about 75 feet in thickness, below which lie the main producing sands in the "L" zone known as L1, L2, and L3.

Structural Features

The Kunghsingshan structure is an asymmetrical anticline sloping between 12 to 18 degrees along the south flank and dipping sharply between 60 and 68 degrees along the north flank. The crest of the structure is believed to lie somewhere near the center of current development. The structure is faulted along its axis and east of the crest.

The subsurface as revealed by the drill closely conforms to the pattern outlined at the surface, although the highest point of the producing sand is approximately 2100 feet south of where it should be expected.

The shallow "K" sand found at about 500 feet averages about 12 feet in thickness, while the "L" sand series, including L1, L2 and L3, are estimated to have a productive thickness of about 85 feet.

One well has been drilled on the structure to 3000 feet and has picked up another sand designated as "M" sand with an estimated thickness of 56 feet at a depth of approximately 1560 feet. This sand outcrops about 15 miles north of the field and shows a total of more than 100 feet of clean, white crossbedded sand in several beds separated by thin shale streaks.

At the western end of the Shihyoukou structure, there is another sandy outcrop which lies below the "M" sand and which appears to have good producing possibilities. This sand will be tested when heavier equipment is available.

Drilling Practice

Laochunmiao field wells are shallow and formations medium to soft, comprised primarily of clays and shales. Lack of adequate mud poses a major drilling problem. Ordinary mud is used down to the sand but, in view of the heavy pressures which resulted in blowouts in early wells, weighted mud is used for drilling in. Weighting materials must be procured locally. At first hematite was used but with poor results. Barite was then used and found excellent for controlling gravity and viscosity. Since

no instruments are available to test mud mixtures, the pH value and water loss has been impossible to estimate. Regardless of how carefully muds were mixed, it was difficult to keep them in condition and the loss of valuable weighting material has been high. Some progress has been made in isolating sections where trouble has been encountered and now mud of 1.4 to 1.6 specific gravity is used. Chemical shortages still make it difficult to obtain the ideal mud for all conditions.

Well locations are cleared off to provide space 80 by 150 feet. Ten-foot cellars are dug and 80-foot steel or 122-foot homemade derricks are mounted on concrete substructures which provide eight feet of working height. This allows for installation of well-head control equipment. Suitable connections on the well-head permit open circulation under pressure when drilling in.

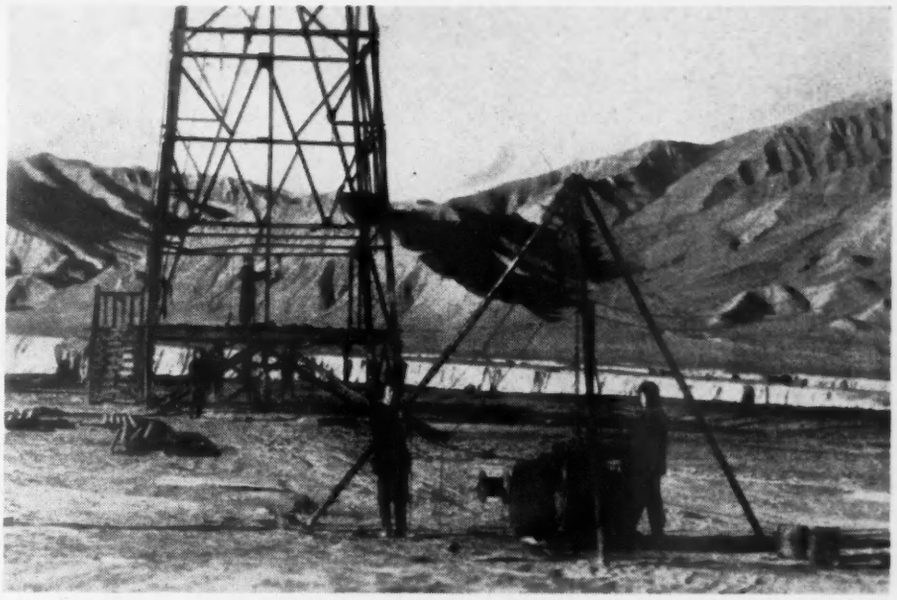
Initial hole is carried through the surface gravels to a depth of 330 feet and 10¾-inch conductor pipe is set and cemented on bottom. The next string of seven-inch pipe is usually set to case off the "K" sand zone and is landed on top of the "L" sands between 1400 and 1650 feet, varying with position of well on structure. Cement is allowed to set three days and then the shutoff job is tested and additional squeeze cementing is done if found necessary before drilling in. Because of previous blowouts the utmost care is exercised in the mud program for completion. Wells are usually bottomed about 63 feet below the base of "L" sand (L3 sand). An electric log is run. A perforated and slotted alloy liner is set with packer on the bottom and the heavy mud is displaced by fresh water.

The development program calls for the drilling of ten wells per year but it is unlikely that this goal will be achieved due to a lack of practically all materials and tubular goods which must be imported and also because of the cold weather which restricts actual drilling to about eight months out of the year.

Production and Reserves

At the end of 1947 the Laochunmiao field had produced 2,760,403 barrels. Fourteen of the 34 wells that have been drilled are capable of yielding oil, but only 11 are producing regularly, all the oil being produced from the "L" sands with the exception of a few thousand barrels which is produced from the shallower or "K" horizon.

According to an original estimate the field is capable of producing more than 75 million barrels. This estimate is based on an average sand thickness of 85 feet, 20 percent porosity, and 60 percent recovery. A later independent estimate places the productive area at 3000 acres and ultimate recovery of 180 million barrels from the "L" sands.



General view of a well cleaning with typical skid dewaxing unit and tripod

During 1947 the 11 producing wells averaged 1700 barrels per day for an average of 155 barrels per day per well; but some of the older wells are making less than the average. Initial production of recently completed wells has been gauged at 300 barrels per day and they have flowed at this rate for an average of two months. All wells are produced by natural flow through choke continuously for from eight to 12 hours daily, sizes of chokes ranging from one-quarter to five-eighths inch. Recently, smaller three-eighths inch chokes have been installed and the wells allowed to flow for from 15 to 20 hours with better results. A series of tests showed that choke size could not be reduced below the smaller diameter cited without increasing gas/oil ratio, due to the high viscosity of the oil. Because the field is of the dissolved gas drive type, gas/oil ratio plays an important part in producing practices and engineers keep a close check on this factor. At the end of 1947 gas/oil ratios ranged from 300 to 1400 feet with an average of 750 cubic feet per barrel.

TABLE 1

Month	Production in Barrels
January	24,847
February	23,550
March	26,740
April	27,070
May	29,139
June	32,600
July	30,732
August	39,608
September	32,200
October	41,425
November	32,483
December	37,451
Total	377,451

High Paraffin Content

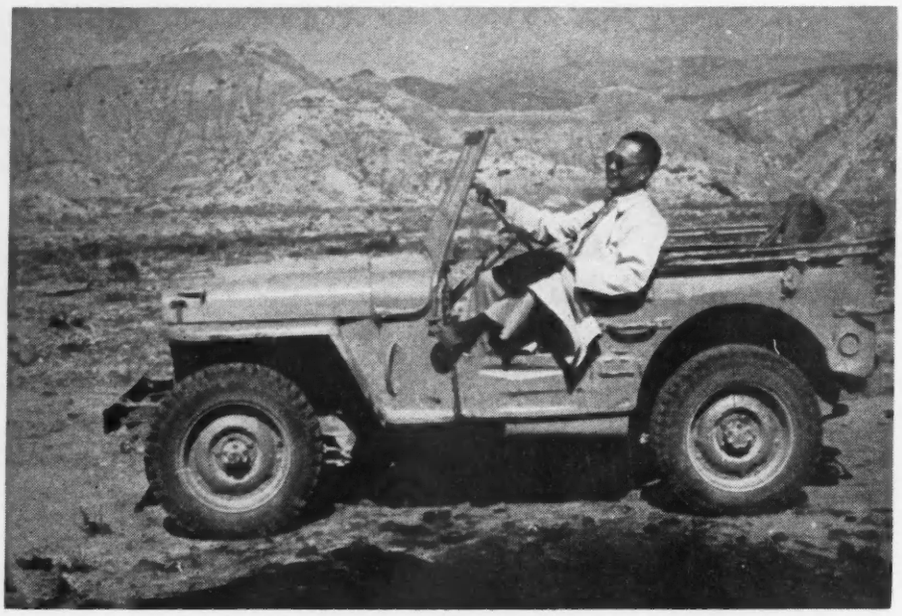
Oil from the Laochunmiao field has a high paraffin content, a gravity of 32.2, a yield of 21.5 gallons of gasoline per barrel, and a pour point of 50 degrees, making it extremely difficult to handle in the field. The crude contains about 15 percent wax and this residue results in clogged tubing and constant steam application to tanks, lines, etc., in order to insure continuous operations.

So far no water has been produced with the oil. Sulphur content is very low enabling the operation of a completely enclosed producing system whereby crude flows from the wells through gathering lines and separators, to tank batteries, where it is delivered directly to the main refinery line through booster pumps.

The quantity of crude produced in 1947 is shown in Table 1. Two wells, Nos. 11 and 12, were shut in due to high gas/oil ratio after they had produced 22,974 and 367,618 barrels, respectively.

Bottom-Hole Pressures and Well Spacing

When the first wells were drilled in the field, original bottom-hole pressures were exceedingly high, although they could not be determined accurately until last year due to lack of testing equipment. However, according to reasonable estimations and calculations from the specific gravity of mud used in drilling in, as well as from the pressures measured from tubing and casinghead, pressures were believed to be between 900 and 1000 pounds per square inch. They



Black spot in foreground shows the oil seepages still very active in Kanyouchuan. Background shows the typical terrain of this area.

certainly were at least 800 pounds per square inch.

Some wells such as the Nos. 52 and 15, showed casinghead pressures of from 700 to 780 pounds per square inch during the initial producing periods. At that time the wells had been shut in for two weeks while the holes stood three-quarters filled with oil, which naturally increased the bottom-hole pressure. Recent tests were made at wells Nos. 56 and I-17 and, after the wells were shut in for more than 12 hours, they showed 600 and 520 pounds per square inch respectively.

Pressures Tested

Early last year bottom-hole testing equipment was received and two wells were properly tested. Some of the recently completed wells indicate high bottom-hole pressures in the initial stage as shown in Table 2.

Despite incomplete statistics it can be assumed that bottom-hole pressures have declined over the field as a whole, but not seriously. The drop is more noticeable when production is stepped up through larger chokes to meet refinery demands. A study of production and pressure curves reveals that bottom-hole pressures decline rapidly during the flush production period and then level off. This indicates to the writer that there is no water drive but rather that production is influenced by sands of high permeability.

Both pressure and production has been greatly influenced by well spacing practices of old wells prior to 1946. In early development, due to a number of unfavorable causes, wells were spaced between 500 and 660 feet and this undoubtedly has caused some decline in bottom-hole pressures. Late in 1946 and after a careful study of well behavior, a wider spacing pattern of about 1870 feet between wells was adopted.

Table 3 shows the pressure records, gas/oil ratio, flowing rate, tubing and casinghead pressure and choke sizes as an average of the last four months of 1947. Four wells were completed during 1947 for a total of 11 producers in the field, with wells averaging from ten to 21.4 barrels per hour through 3/8- to 3/4-inch chokes.

TABLE 2

Well No.	Well Depth M.	Date of Completion	Date of Testing	B.H.P. Lbs./ Sq. In.
60	400.95	May 27, 1947	May	771
96	535.58	July 31, 1947	Aug.	1050
56	577.00	Sept. 2, 1947	Sept.	1080
I-17	644.35	Oct. 18, 1947	Oct.	839
Average	504.45			935

Future Prospects

In its search for new reserves the Chinese Petroleum Corporation plans an aggressive drilling and exploration campaign. Surface geological reconnaissance has resulted in the outlining of many anticlines where petroleum possibilities are considered extremely good. Reconnaissance reveals there are many potential oil areas in the vast northwestern region of China and at least three new reserves have been found along the Old Silk Highway, although estimates of reserves are not available.

Principal Problems

Principal problems confronting the operator include the elimination of paraffin troubles in producing wells; determination of proper choke size to assure the maximum and most efficient production rates; and improving of mud and cement to assure more efficient well completions. Another important need is a research laboratory for the study of sand fluids. These and other important considerations are part of the company's 1948 program in its efforts to establish the most efficient drilling and production methods in the Laochunmiao field.

TABLE 3

Average Figures of Gas-Oil Ratio, Flowing Rate, Choke Sizes of Laochunmiao Field, From Sept. to Dec., 1947

WELL No.	Oil and Gas Ratio (Ratio)	Flowing Rate (Bbl./Hr.)	Choke Size (In.)	Average Pressure (Lb./Sq. In.)		Bottom Hole Pressure (Lb./Sq. In.)
				Casing	Tubing	
16	595	9.33	3/8	230	125	290
18	563	16.10	3/8	320	230	347
19	594	7.50	3/8	180	70	403
32	679	9.80	3/4	304	163	335
33	518	5.20	1/4	291	231	....
42	1,058	9.70	5/8	325	220	355
50	998	12.10	3/8	380	307	475
56	340	21.40	1/2-3/4	477	182	975
60	1,717	10.95	1/4-1/2	300	238	453
96	420	14.80	1/2-3/4	300	137	721
I-17	476	16.23	1/2-3/4	433	213	839

TABLE 4

Well Production Data

YEAR	No. of Wells	Producing	Production Bbls.
1940	4	6	9,872
1941	3	8	86,587
1942	2	8	339,581
1943	8	9	449,725
1944	6	12	502,198
1945	3	14	481,360
1946	2	15	513,629
1947	6	16	377,451
Total	34	..	2,760,403

OUTLOOK BRIGHT for Greater Oficina

by

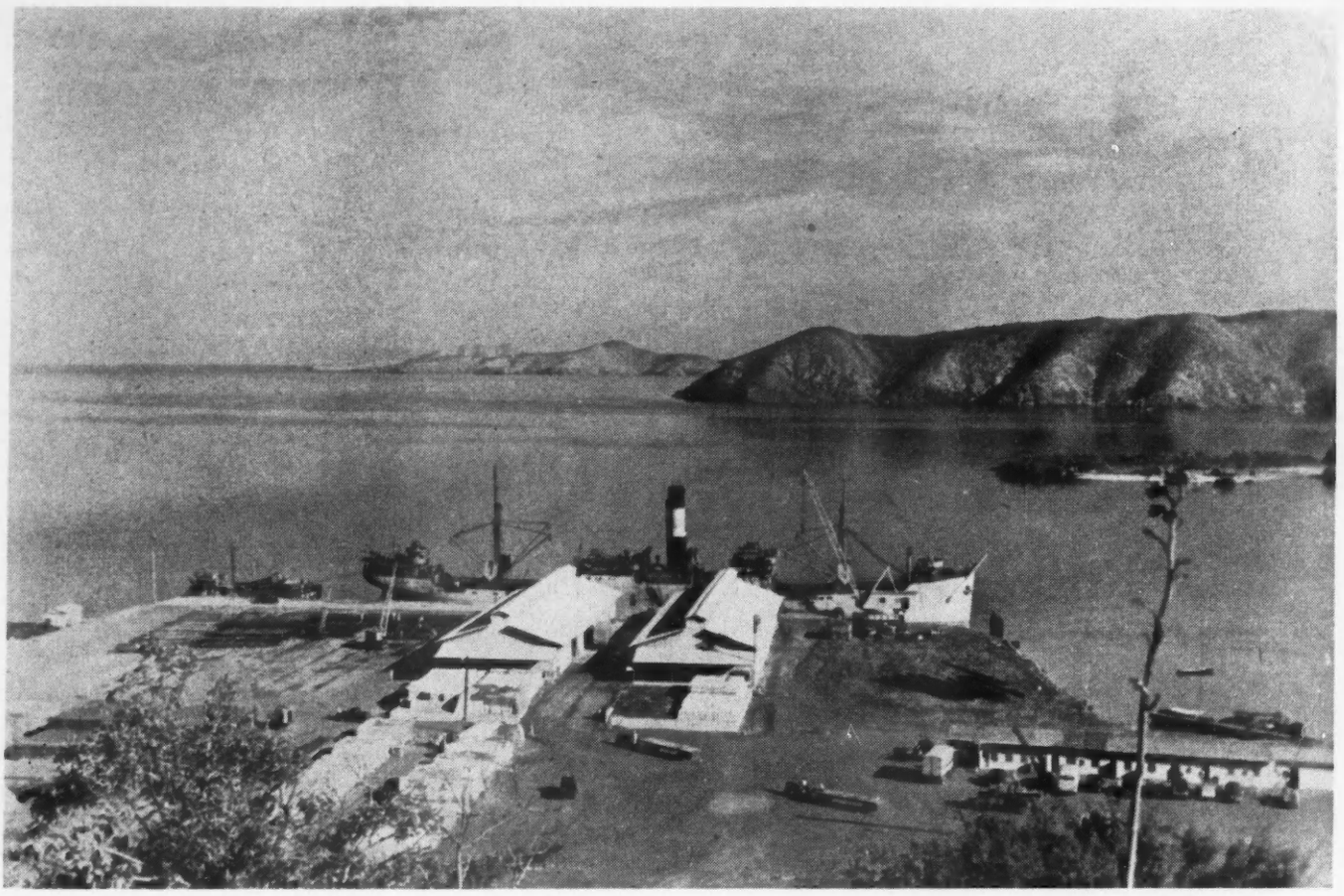
GEORGE O. IVES
International Editor

IN SPITE of the numerous separate producing pools already found in the Greater Oficina area, the nature of the accumulations suggest that the present high ratio of success in exploratory drilling will continue for some time. At the same time the great number of sands to be exploited under a given surface area should insure a high percentage of flowing production for many years, particularly in view of the sound production methods practiced.

THE six principal districts of the Greater Oficina area in eastern Venezuela constitute one of the most interesting oil provinces in Venezuela. The principal reason for its interest lies not so much in the volume of oil produced, although this is considerable by almost any standard, as in the nature of the fields from which the production is drawn. The problem of finding and producing oil at Greater Oficina might be said to be somewhat simplified by the fact that all of the presently known production comes from one principal formation. However, the problem is enormously complicated by the fact that only rarely is a reservoir continuous over any great area, and by the multiplicity of separate and distinct producing sands.

Greater Oficina is the name given to the group of fields including and surrounding the Oficina field, discovered by Mene Grande Oil Company, all of which are geologically related in that they produce from the same general formation and many sands appear in all fields. However, each one is a separate and distinct reservoir formed by faulting in the multiple-sand Oficina formation. The largest single field as to area is that surrounding the discovery well, covering 13,500 acres and known as Oficina

Picture above shows manifold through which crude from Greater Oficina and other Eastern Venezuela fields flows to ocean tankers.



View of cargo dock at terminal on the Caribbean, through which comes all supplies for use in the Greater Oficina area.

proper. This field is not just one pool in the usual sense, but is made up of something like a dozen or more separate accumulations against individual faults which actually break the field into many separate reservoirs. A number of major faults have been identified and production found at various points along them, but numerous others have been found and are still being found and confirmed. The nature of the area is such that a high degree of success has been achieved in wildcat and outpost drilling. Since the Oficina field actually came into production in 1937, two-thirds of the exploratory wells have found oil.

Location

Greater Oficina is located near the southern extremity of the great Orinoco Basin, which contains practically all of the fields producing in eastern Venezuela and lies entirely within the State of Anzoategui. The formations rise in a comparatively gentle slope toward the south and southeast. Accumulation is almost invariably on the north side of the faults, whether upthrown or downthrown to the north, although in a number of cases production is coming from both sides of faults.

The Mene Grande Oil Company drilled its Oficina 1, first test for the area, on the strength of torsion balance and refraction seismograph geophysical work, since the nature of the terrain is such that almost no surface features signifying subsurface structural conditions exist and there were no surface seepages of oil within 75 miles or so of the original location. It is situated on terrain consisting of only slightly rolling prairie or savannah with no obstructing timber except along the few streams. The savannah itself is almost treeless except for a few stunted trees attaining an average height of about ten to 12 feet. It is covered by a type of tough bunch grass. Located 105 miles south of the northern coast, for which Puerto la Cruz is the principal port, it was formerly accessible by savannah roads which were not too difficult of passage, but it is now connected to the coast by an asphalt highway built by the company shortly after the field was shown to be a major discovery.

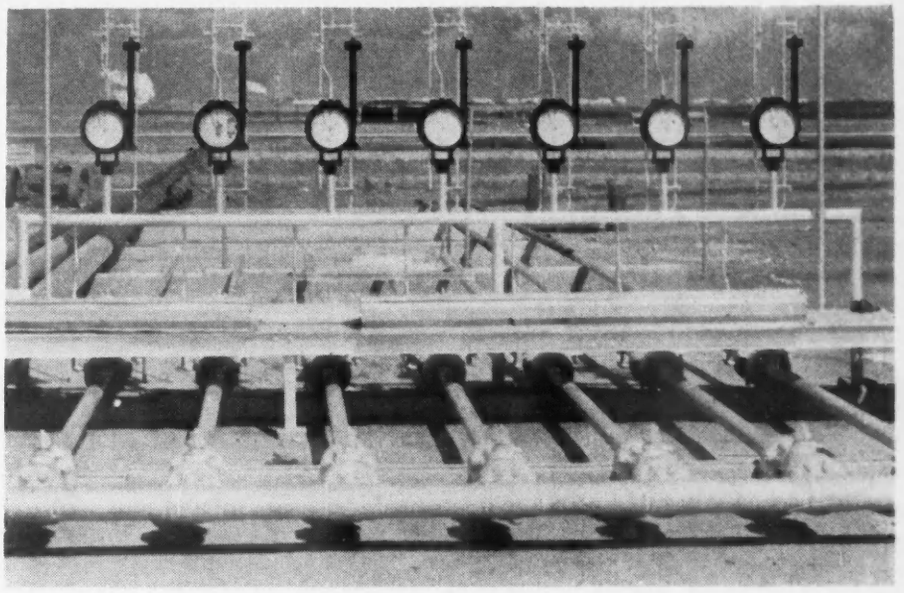
The discovery was spudded during 1933, but drilling was sporadic until it was actually completed early in 1937 at a depth of 6184 feet. Eleven different sands were found between 4000 and 5995 feet. Initial production was 1325 barrels a day through a ½-inch choke, taking in an interval of 5292-5995 feet. At this time the only other production in eastern Venezuela was at Quiriquire, more than 100 miles to the northeast.

Expansion of Area

Following the opening of the new field, development was rapid and a pipe line was built to Puerto la Cruz through which deliveries of oil started in the middle of 1939, with the first actual shipment of exported crude coming in December of that year. The area has expanded until the Oficina group now comprises 29 separate fields, many of which have never received full development. During the war years development was concentrated in the areas where the most return in crude oil could be expected for the critical materials used. In this period, where a maximum of production was needed from each well, the nature of the fields was well suited to stepping up production per well, since the multiple sands made multiple completions practical and in some of the areas practically all of the wells were dual or triple-zone producers.

Since the first shipment of oil in 1939, the Greater Oficina area has produced a

cumulative total of 232,682,694 barrels of crude which, while a relatively small percentage of all the oil produced from Venezuela, is 30 percent of all of the production from eastern Venezuela. During 1947 its output had continued to rise until its production for the year was 55,981,326 barrels, or 46 percent of all the oil from the eastern part of the country during the year, and at the end of the year it was producing daily more than 44 percent of the daily production from the region at a rate of 340 barrels per day per well, which compares with an overall Venezuela average of 219.7 barrels daily per well.



Discharge manifold and meters in Guara field's new gas injection system.

Guara Field

One of the most remarkable fields in the entire group is Guara, which, although it was only discovered in 1942, has already produced more than 81½ million barrels of oil. The West Guara field, including Guico, which is operated by Socony-Vacuum Oil Company of Venezuela, has proved more than 700,000 acre-feet of productive sand, although its surface area is only 3350 acres and none of the individual sands are relatively thick bodies. The field has identified 47 separate and distinct producing sands, some of which are sheet sands which underlie almost the entire field while others are lenticular and cover only a portion of the area. A large percentage of the completions are multiple-zone wells. At the end of the year the 174 wells at Guara were producing at a rate of 81,198 barrels a day, or nearly half the rate of the entire Greater Oficina area with its 27,000 surface acres.

The character of the structural conditions in the area is such that, although every known method of geophysical investigation has been used in the area, the methods found to be most reliable in the area are reflection seismograph combined with structure drilling. The structure drill is used in conjunction with all other methods which might be tried and has come into universal use throughout the Orinoco Basin. Good results are obtained in core-drilling to a depth of 2500-3500 feet, even though formations reached are several thousand feet above the Oficina formation from which the production comes. The system has become well established and Mene Grande Oil Company has developed or adapted several fairly heavy portable outfits with which holes below 3000 feet in depth are completed in four days. On Mene Grande's operations, no wildcat wells are drilled without first being checked by structure drilling.

Notwithstanding the practice of concentrating available drilling equipment and materials in the known producing areas, wildcatting through the years since the close of the war has been brisk and has resulted in important additions to the reserve of Greater Oficina. Notable has been the Nipa area to the north which was first opened in 1946 but received the greater part of its drilling in 1947, when Socony-Vacuum and Mene Grande each maintained rigs in the area. Its producing formations have been found to be quite similar to those of the Guara area, although without as many separate sands. It is also somewhat deeper, wells being drilled to depths between 7100 and 7800 feet, whereas in Guara the deepest formations drilled are above 7000 feet, since the gravity of the oil decreases with depth and deeper formations yield heavy oil. Nipa, consisting actually of two areas, now has 28 producers and accounted for nearly four million barrels of oil during 1947. Another important development of 1947 was an extension to Leona, most easterly field in the original group, which just about doubles the area through connection of the main field with scattered production to the northwest and west.

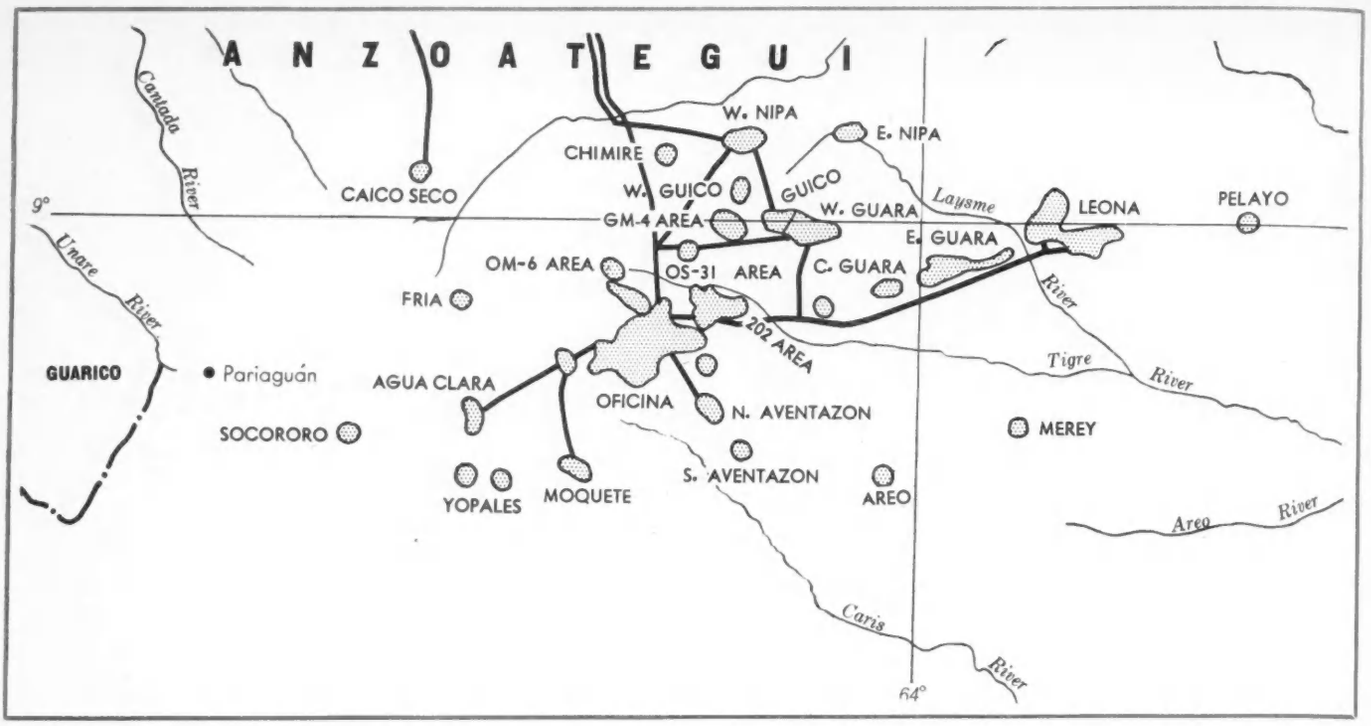
Wildcat Drilling

A number of other areas have been opened in which no drilling has taken place since completion of the discovery well and others in which drilling has consisted of only one or two additional wells since discovery. All of these will come in for greater attention as the producing potential of the presently active areas becomes fully developed. In the meantime, from one to three rigs are kept active in wildcat or step-out drilling to determine the value of new prospects. The nature of the area is such that it will require much more time, thought, and actual drilling before it can be assumed that all of the oil in the immediate area has been discovered, and still more time before it is reduced to possession by full development of each individual area of accumulation. Although the pipe line system is constantly being expanded, many of the smaller areas still remain unconnected and will probably remain so until they receive enough drilling to build up greater producing potential.

During 1947 Socony-Vacuum Oil Company opened the Chimire between the Nipa and Oficina fields, and Mene Grande has found new areas at Fria and at Toco, farther to the northwest. Still unevaluated is the discovery by Venezuela Atlantic Refining Company and Pantepec of the Pelayo field, the most easterly production in the immediate area, where one producer has been drilled.

There are now a total of 25 rotary drilling rigs in operation in the Greater Oficina area, 20 of which are by Mene Grande Oil Company, four by Socony-Vacuum and one by Atlantic-Pantepec, representing a considerable amount of drilling activity for an area discovered more than ten years ago.

The pipe line system originally consisted of a single 16-inch line from Oficina to Puerto la Cruz and the shipping terminal on the Caribbean. The increase in production has made constant addition necessary, first in pumping equipment and later in the form of loops, until the line is now looped from about nine miles north of the intermediate Anaco station to just outside the terminal, or more than half its length. Early in 1948 its capacity was rated at 180,000 barrels daily and this was being stepped up by addition of new pumping units at both the Oficina and Anaco stations. An imminent congestion in the system was



The producing localities of the Greater Oficina area, many of which have not been connected by pipe line.

relieved during the past year when Socony-Vacuum constructed an independent 12-inch system from its Guico and Nipa fields of Greater Oficina to Puerto la Cruz, where it terminates at Compañía Consolidada de Petróleo's Chaurie terminal and shipping point. At time of latest report this new line was handling about 25,000 barrels of crude daily, and together with additions to pumping capacity on the Meneg line, will care for some expected expansion in production. Although gravities of crude range from as low as eight to as high as 57, most oil produced is in the medium range and the common stream runs about 35 degrees.

Drilling problems in the area are not acute. In holes averaging about 6500 feet deep, about half of the hole may be made with drag bits or equivalent, while only at the greater depths where formations are more compacted is it necessary to use rock bits. Pressures are not excessive and mud problems are more or less routine. The only problems of any magnitude encountered are in cementing for isolation of the various sands in the wells. Two-stage cementing is practiced, and squeeze jobs made before perforating casing for completion. The general practice is to set from 700 to perhaps 1100 feet of 10¾-inch or 9⅝-inch surface casing, with a full oil string of 5½-inch or seven-inch casing set to bottom of the producing section and perforated for completion. In this area, as in others elsewhere throughout the world, there has been some experimenting with oil-base drilling muds, but at Greater Oficina it has not been in progress long enough to form any definite conclusions as to whether it is advantageous in this particular area.

With the exception of some equipment being used on exploratory wells, most of the rigs are powered by steam, since a considerable amount of gas is available in the fields.

Recently, in view of the number of flowing wells and the problems to be presented with depletion in multiple-sand producers, a great deal of thought has been given to pressure maintenance and re-pressuring, and two projects are now being started in the area. In addition an experiment is being carried on with water flooding in one of the segments of the Oficina field.

Water-Flood Project

The water flooding project was carried on on a small scale, injecting fresh water into a relatively small fault block with a channel-type sand, the entire block covering no more than 200 acres. The injection started in 1946, using one injection in a closed system. Since the beginning of the project, 1½ million barrels of water have been introduced into the system and 300,000 barrels of oil have been recovered as a result of the water flooding.

The West Guara pressure maintenance plant was about ready to go into operation early this year. This plant was designed to maintain, as far as possible, pressures on the principal producing sands in the West Guara-Guico fields to prolong the flowing life of wells drilled to these sands. The plant, with equipment now installed, can handle approximately 29 million cubic feet of gas daily, taking gas from the field systems at 50 and 150 pounds, compressing through three stages to a discharge pressure of 1800 pounds, and injecting into the sands. Three sands have been selected for the initial operation, using five injection wells in the beginning. One new well has been drilled especially for injection of gas and another four wells will be converted. The field actually produces about 40 to 45 million cubic feet of casinghead gas daily, but the remainder over and above the amount to be injected will be vented to the air. At present all of the gas is being vented. No provision has been made for stripping the gas before injection. In the beginning the only liquid to be taken off is that formed between the stages of compression. The plant will have six 800-horsepower units driven by engines using field gas as fuel.

A smaller plant is about ready to start up in the Oficina field designed to handle approximately 14 million cubic feet of gas daily, all of which is to be injected into the Oficina L-1 sand, the largest single producing reservoir in that area.

The open nature of the country readily lends itself to movement of drilling equipment, and most rigs are mounted so that they can be skidded as units from one location to another, minimizing the time consumed in tearing down, moving, and setting up.

Through an operating agreement, to more efficiently develop properties with a minimum of duplication of facilities, Mene Grande operates all properties owned by Creole Petroleum Corporation in the area, delivering the crude for their account, while Creole reciprocates in like manner in other areas.

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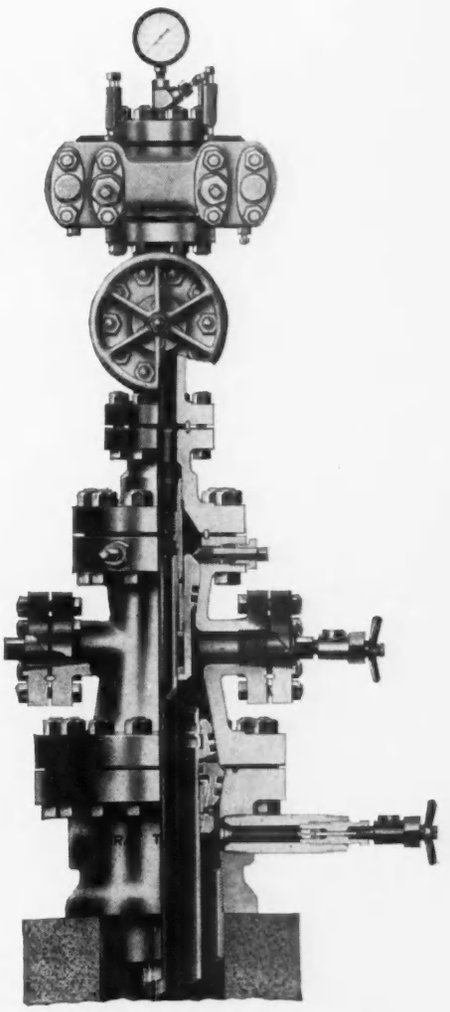

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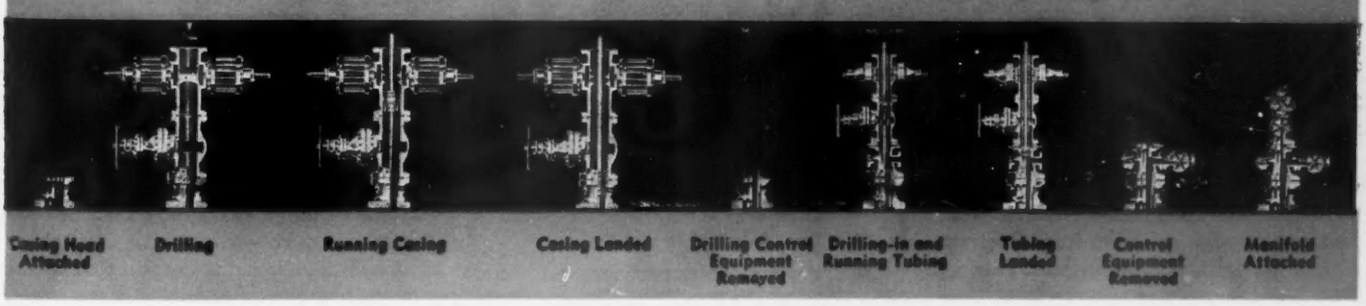


TRACTOR TRAIN FREIGHTING *in the Arctic*

By T. C. MATHEWS and E. D. SPAULDING

THE U. S. Navy has been interested in the development of the area in Alaska north of Brooks Range as a "petroleum reserve" for more than two decades. In 1923 the area north of the Brooks Range and west of the Colville River was withdrawn from Public lands and the Naval Petroleum Reserve No. 4 was created. In 1944 the Navy decided to engage in an active exploration program in the reserve. Commodore W. G. Greenman, USN, was named director of the reserve, and Captain Bart W. Gillespie, USNR, commanding officer of construction Battalion 1058. was charged with the responsibility of all field operations.

In August, 1944, the battalion, with construction materials necessary, was shipped to Point Barrow, Alaska. A base of operations was established at Point Barrow, the camp constructed, and in February, 1945, winter freighting operations were begun, hauling the necessary materials for drilling a deep test at Umiat. In addition, supplies and equipment were transported to the Cape Simpson area to support a geophysical operation and the drilling of a number of shallow test wells.

The victory over Japan did not deter the interest of the Navy and in January, 1946, a contract was let to Arctic Contractors, composed of Lytle and Green, general contractors, and Hoover, Curtice & Ruby, Inc., of New York, geophysical contractors and petroleum consultants, to complete the project known as Bureau of Yards and Docks Contract NOy-13360. Bart W. Gillespie, USNR, released from the Navy, was named project manager. Commander P. W. Roberts, USN, was named officer in charge of construction.

WINTER FREIGHTING operations conducted during the part of the year between the end of January and first of May are among the more important logistic factors in development of Naval Petroleum Reserve No. 4. In order that the designated program be carried out during the following season, 85 percent of all materials used must be freighted during the winter season previous. The work necessarily must be done during the season of the year when wind and weather conditions are extreme. From January 19, 1947 to June 12, 1947, 5975 net tons were moved over the Arctic Ocean and across the tundra for a total of 738,513 net ton miles.

The lessons learned by the Sea Bees were invaluable in the freighting operations that followed in 1946 and 1947. The operations of each year yielded valuable information that was necessary to plan intelligently and execute a freighting operation conducted during part of the year when temperatures may drop to —50° F. and wind velocity reaches 60 to 70 miles per hour.

The basis for this article is operations conducted during the season of 1947, between January and June.

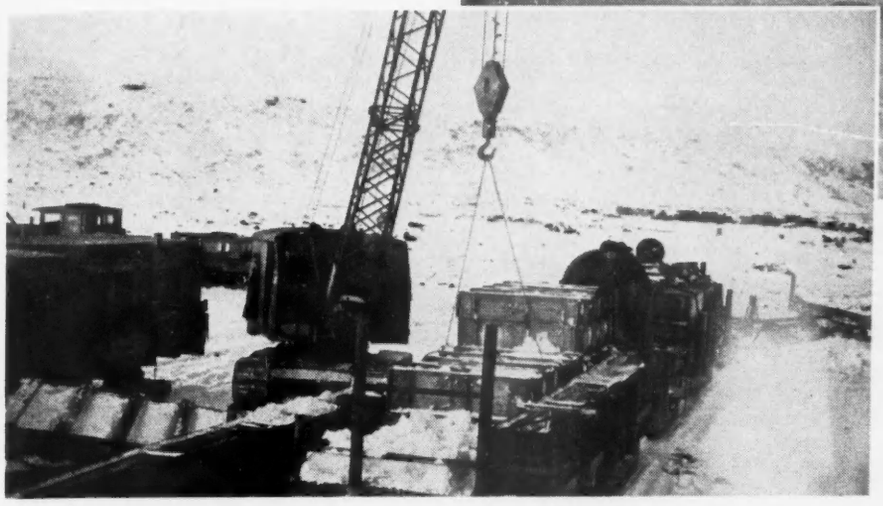
Preparations for Freighting

As soon as the contractors are notified in November of the following year's plan of operation, work is begun making preparations to form the necessary number of tractor trains to transport the required materials and supplies for the coming season. Equipment is overhauled, new equipment is designed based on the lessons learned, and nothing is left undone that will produce an efficient, safe, freighting operation.

Prior to the commencement of freighting, all routes must be surveyed and carefully staked. This is because much of the route passes over the Arctic Ocean where danger of pressure cracks is common. All unsafe ice is carefully detoured

RIGHT: Two types of transportation in the Arctic.

BELOW: Unloading at Umiat.



and the trail carefully marked with stakes carrying a red flag.

This work is done at a time of year when there is no daylight and in the Arctic twilight it is always difficult to discern terrain. The sky and ground blend into a blank gray which offers no contrast and therefore no discernibility. The accompanying work feasibility chart expresses visibility and restrictions to visibility, such as fog, but no method has been evolved to express discernibility, which is used for the lack of a better word and here means the ability to see a white object against a white background. Optically, it is necessary that the object cast a shadow before it can be discerned, even though the visibility of black objects against a white background is unlimited.

At any time after December 15 trail marking is started. Routes are first inspected and surveyed aerially. A small bush plane, equipped with skiis for landing on the snow, is generally used. When a section is decided upon, stakes approximately three feet long with red turkey cloth on one end, weighted with a short section of one-half inch reinforcing rod or similar material, are dropped from the airplane at intervals of approximately one mile. Where it is necessary, as is the case on dangerous ice or in meandering river channels where deep snow drifts occur, stakes are dropped at more frequent intervals. The course of rivers can easily be followed from the air where it would be almost impossible to follow their course by ground. This is particularly true at the mouth of streams that empty into bays or inlets. Where the banks are not discernible and the route not properly marked, the train could easily find itself in difficulty. Needless to say, the train is taken over ocean ice or river ice wherever possible.

Marking Route

Following the aerial staking, the route is marked in detail from the ground. An M-29C weasel pulling an M-19 trailer mounted on skiis is used for this operation. Both of these pieces of equipment were designed and both used during World War II. The weasel is completely winterized for operation in sub-zero weather. The canvas top is removed and a cab constructed on one-half inch plywood and celotex is placed on the weasel. Care is taken to insure proper installation. A dilution system is installed on the engine to insure starting in extremely cold temperatures. In addition, a small tank containing starting fluid is piped to the fuel system. This is operated by the hand primer pump mounted on the weasel dash board. When this system is operated with care, it is possible to start the engine in temperatures as low as —40° F. after it has been standing without running for a period of eight to ten hours.

For communication purposes, a Navy Bureau of Ships TCS-13 transmitter and receiver, powered by the weasel battery and mounted in a shock proof rack, is used. This equipment operates with reasonable success up to a radius of 100 miles. A search is still in progress for a stronger and more reliable set although the TCS-13 is well adapted to this use because of its compactness and sturdy construction. A regulation whip antenna is used for an aerial. Communication is maintained between the base at Barrow and the trail vehicle at all times. Contacts are made each evening and morning and the set at Barrow is monitored to handle emergency calls.

The weasel and trailer supports two men; that is, complete subsistence is derived from it. It is also their means of transportation in scouting the trail. Supplies are brought to the weasel at intervals of five to ten days by a bush plane. This is necessary as it is possible only to carry sufficient gasoline and food for approximately ten days to two weeks. This period is governed by the nature of the weather and difficulties encountered in picking proper routes. The scouts are

About the Authors

T. C. MATHEWS is project superintendent of Arctic Contractors, having joined that organization in 1944. Prior to this, he was an engineer in the Northwest Service Command doing construction on the Alcan Highway and Canol Project. He has also been manager of Gold Mines Limited and American Creek Operating Company.

E. D. SPAULDING, chief engineer with Arctic Contractors, joined the firm in 1946 after his discharge from the Navy. He was formerly general superintendent of Great Eastern Quicksilver Mines in California, general superintendent of North Camarines Gold Mining Company in the Philippine Islands, and engineer for International Engineering Company in Manila.

forced to live under very rugged conditions and therefore it is necessary to choose men who are strong and hardy physically and what is equally important, who have thorough knowledge of the country and the ability to live under extreme cold weather conditions.

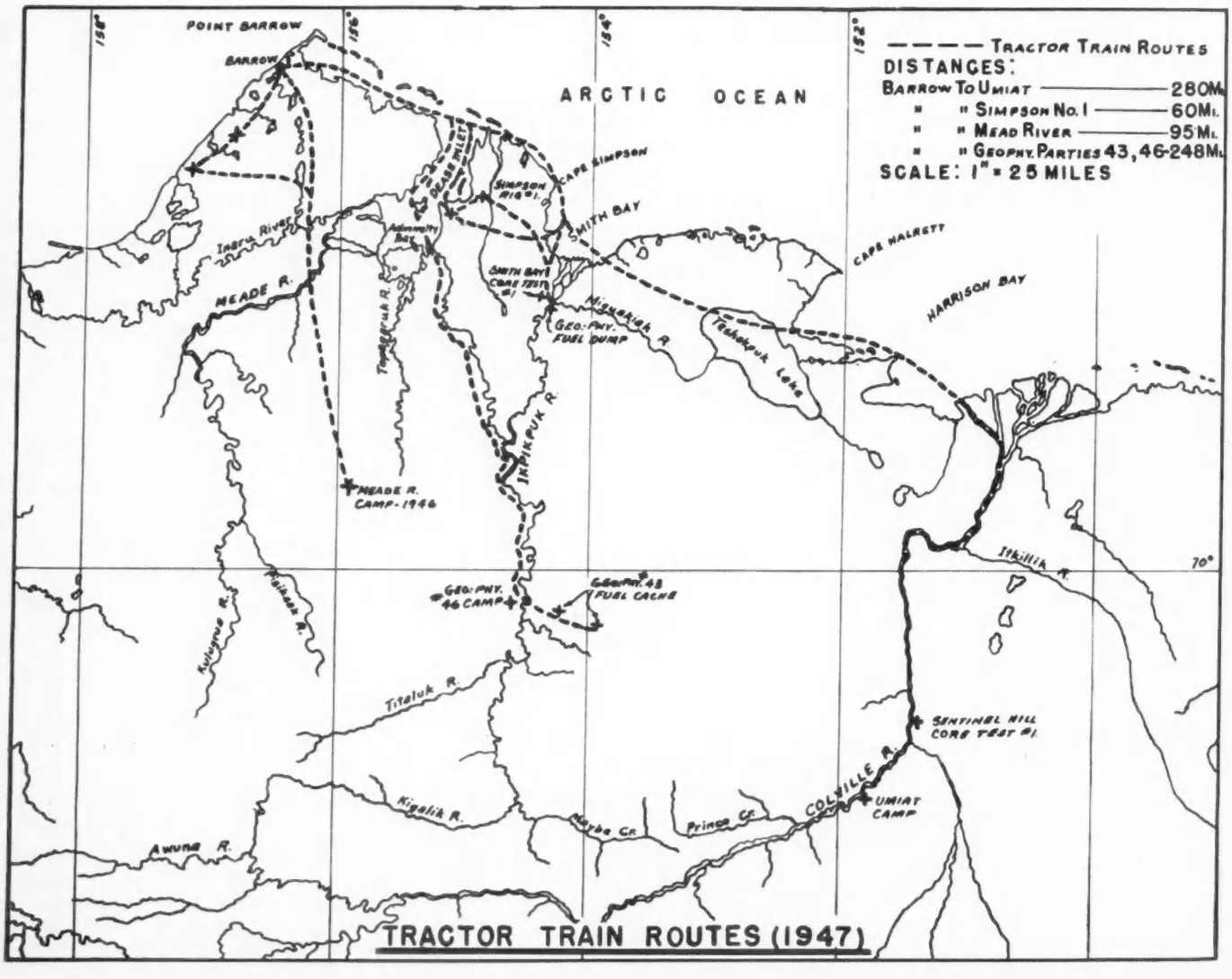
Freighting Equipment

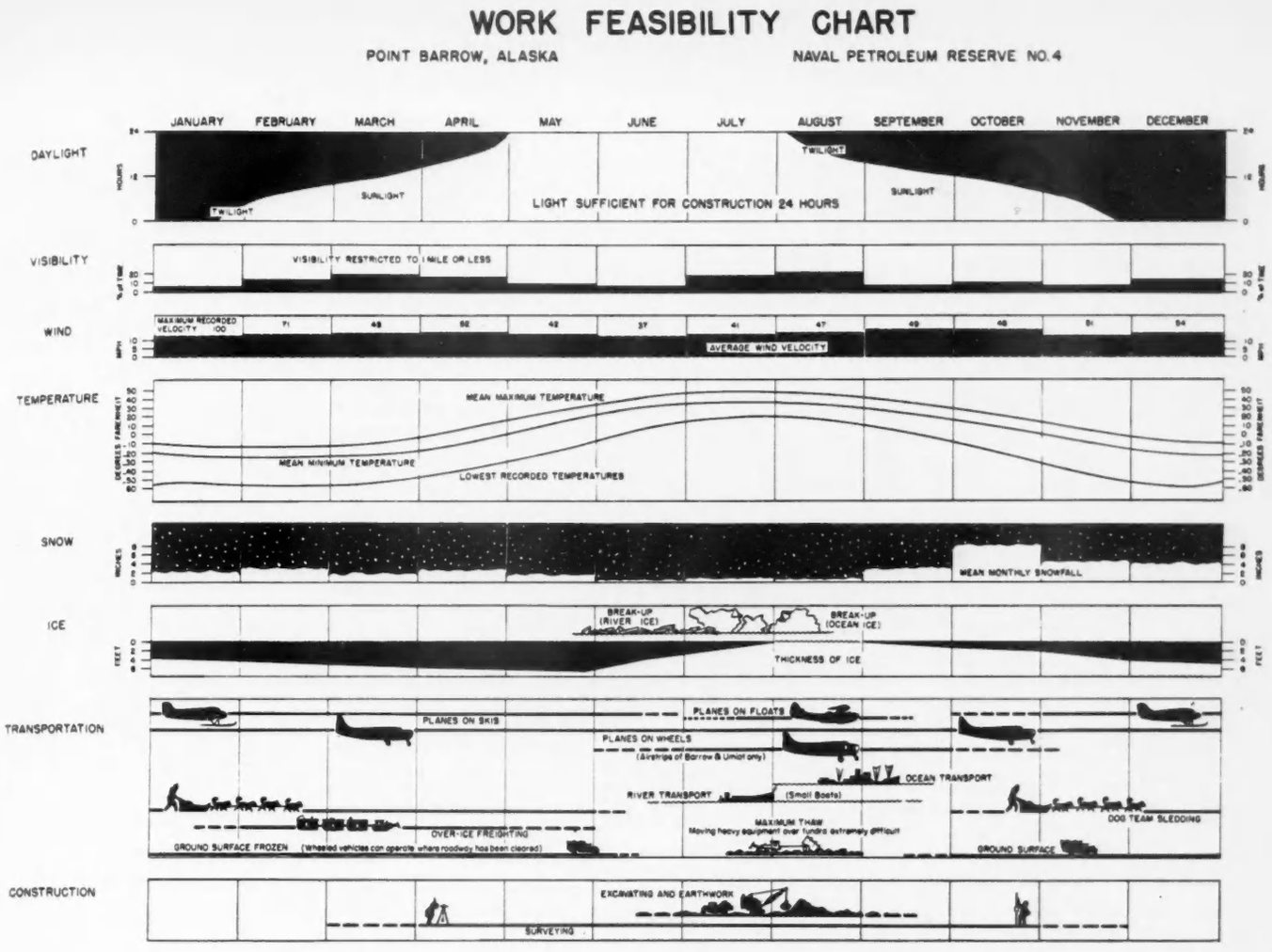
The tractor equipped with a winch is the prime mover used throughout. In order for it to operate at a high degree of efficiency, it is run through a winterizing process prior to the beginning of freighting. The standard cab is redesigned, placing all controls within the enclosure. An escape hatch is constructed on the roof of the cab. A large window is installed on the left hand side below the windshield to enable the operator to use the dozer blade when needed. A small louvre is cut in the front equipped with a shutter to make use of engine heat. The top rollers are removed and replaced with 6x8-inch oak skid blocks. Ice and snow grousers are exchanged for the mud pads that are generally used throughout the summer season. All tractors are equipped with a standard front power takeoff although only the lead tractor in a train carries a snow plow or dozer blade. Some experimental work has been done to insulate the drum assembly to prevent sticking or freezing, although the first installation used did not allow enough play for the cable to run free. Minor alterations have been made to eliminate this trouble in the future. In addition to the aforementioned changes, all equipment is thoroughly checked and overhauled where necessary. Summer lubricants are drained and replaced with winter lubricants.

The bob-sled and go-devil are standard equipment although modifications were made in the original design. Both have been used with equal success, although preference is shown for the bob-sled because of its better tracking qualities on the trail. However, the go-devil also has its place in freighting operations. The go-devil on smooth ice tends to yaw and, unless used in combination with the bob-sled, causes the operator minor difficulty in keeping the load on the trail. The equipment has proven completely satisfactory.

Each train carries a sleeper and galley wanigan in addition to a repair shop mounted on a go-devil. Both the sleeper and galley, each mounted on a bob-sled, are the result of variations and adaptions of the standard freighting wanigan used throughout Alaska and Canada. They are constructed at Barrow and every effort has been made to provide as much living space as possible in a limited area. Each sled bed is eight feet by 24 feet, as it is necessary to provide quarters and mess for nine men, the usual number of crew members per train.

Both structures are of frame construction, sheathed on the outside with drop siding nailed to 2x4-inch studding, and lined inside with insulation between the studs. Three-fourths inch celotex is used on the interior. This provides adequate insulation qualities. Each galley or mess is equipped with a motor driven, oil fired cook range, necessary storage space for supplies, and a movable table which will seat nine to twelve men (see drawing). A folding ships-side bunk is placed on the wall for the cook's use. The sleeper is of similar construction equipped with an oil fire space heater with a 50,000





British thermal unit capacity, double bunks to sleep eight men, washing facilities, and communication equipment. Navy Bureau of Ships TCS-13 transmitter and receiver is installed in each sleeper to provide each train communication with Barrow base camp at all times.

The repair sled is a standard go-devil housed with a frame structure covered with canvas. Within the go-devil is contained a small gasoline powered 10 kilowatt light plant which furnishes light and power to the train, a gasoline engine driven arc welding machine, an electric driven fuel pump for refueling, and a small set of spare parts for making emergency repairs on the trail. In addition, an adequate supply of spare winch lines, shackles, load binders, and other miscellaneous gear is provided to meet almost any emergency. Enough is provided to keep the equipment moving on the trail. Major repairs to tractors are not attempted and to date have not been necessary. The repair sled is a vital factor in keeping the train moving.

Train Operations

The tractor train as used in NPR 4 consists of five tractors and 14 bob-sleds, or five tractors, ten bob-sleds, and nine go-devils. Two bob-sleds are used by the wanigans, and one go-devil for repair wanigan. This is dependent on the make-up of the train and load hauled. A sleeper wanigan and galley wanigan with repair sled are pulled by the lead tractor. An M-29C weasel is used by the train foreman as a scout vehicle. The lead tractor is equipped with a snow plow and acts as a trail breaker; therefore, it is necessary that the draw bar pull be less than on the following tractors. The load capacity per bob-sled averages approximately 18 tons net or 23 tons gross. Loads are 14 tons net or 17 tons gross per go-devil. Generally speaking, the net load capacity per tractor is approximately 64 tons, that is, when two bob-sleds and two go-devils are hooked to a tractor. This is generally considered the maximum load the prime mover can move, but bulky loads frequently do not permit maximum capacity due to the raising of the center of gravity which endangers the sleds to tipping on rough trails.

It has been the practice to operate three separate trains. Each train can operate individually or may travel with other trains, although no effort is made to keep together. A foreman is in charge of each train and his crew consists of five tractor operators, a mechanic, an oiler, and a cook. The safety of the train is his responsibility and on new or unfamiliar routes, he must scout in advance continually. This is particularly true where routes pass over the ocean or rivers. Pressure cracks and glaciers arising are an ever-present danger. Although the trails are staked and precautions taken to avoid unsafe ice, the shifting of the packed ice can make unsafe sections of the trail that previously were not dangerous. Glaciers on river routes are also a constant danger.

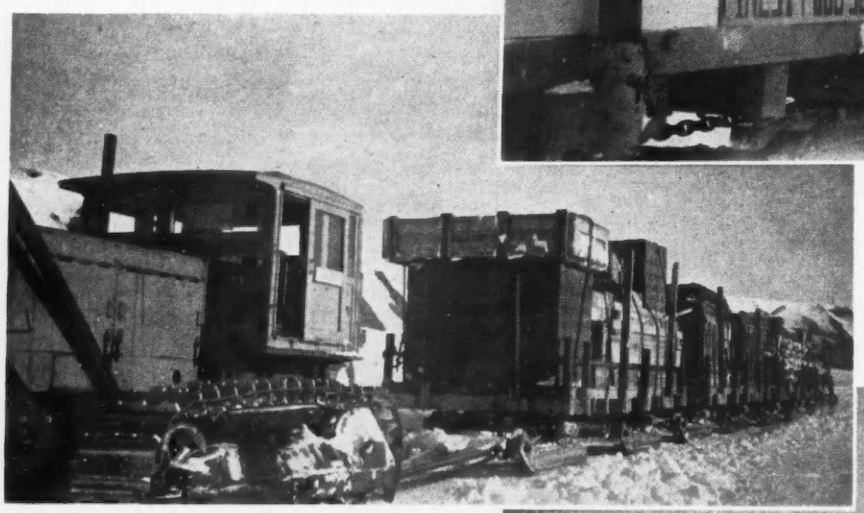
A train operates on a basis of 15 hours per day. Refueling, lubricating and the making of minor repairs is done at noon and during the evening meal. After dinner, the train continues, shutting down at 9:30 p.m. This schedule is maintained when good weather prevails, when it is not necessary to tie up because of blizzards or other reasons of poor visibility. Tractors idle during shutdown periods and are either idling or working continually until a round trip is completed. Upon completion of the trip, the tractors are run through the shop, serviced and necessary repairs made.

The men chosen to operate the trains usually have done considerable work in

LEFT: Bush plane servicing a train.

BELOW: Galley Wanigan hitched to lead tractor.

BELOW: Sleds loaded with drilling supplies.



BELOW: Loading sleds at Barrow.

this line. Too high praise cannot be given them as they work under hazardous conditions and during a season when climatic conditions can be most uncomfortable. Besides being competent operators, it is necessary for them to possess a knowledge of the tricks of the trade required to keep the train moving. Many have worked in Alaska for years doing similar work and their knowledge has proven invaluable. Although precautions are taken at all times to keep the train out of danger, the crews must be continually on the alert in order to safeguard their own lives and the lives of others who may be following behind. No fatal accidents have been experienced although more than a million ton miles have been freighted by the contractors.

Lubrication and Fuel

Lubrication of equipment offers no real problem in spite of the low temperature encountered. Tractors are serviced each day by the respective operators and equipment refueled. Oil is changed at the end of each run when the trains are returned to Barrow unless an emergency occurs when changes are made on the trail. The type of lubricants and fuels used are listed in the following tabulation:

The weight of oil used in the tractors depends on the season of the year although during the period of freighting, from January to the end of May or first of June, SAE 10 (9110) lubricating oil is used in the tractor engines. SAE 50 (9500) is used in the transmission and final drive during the first part of the season, but in April SAE 50 (9500) and SAE 140 (5190) were used in equal proportions in both transmission and final drive. Where it has become necessary to use gear lubricants of more viscosity than SAE 90, it has been a practice to dilute SAE 140 with kerosine. Lubricants purchased for use for the freight-

A DRILLING WELL SILHOUETTED AGAINST A TYPICAL EASTERN VENEZUELA SKY

SCHLUMBERGER is an "old hand" in Venezuela, having enjoyed close fellowship with Venezuelan oil operators since 1929. As a result of the unselfish cooperation and encouragement of these men, Schlumberger has developed a substantial service organization in Venezuela and has always made available to them the most modern techniques. In fact, the Dipmeter—now a widely used Schlumberger service—first won unreserved recognition there.

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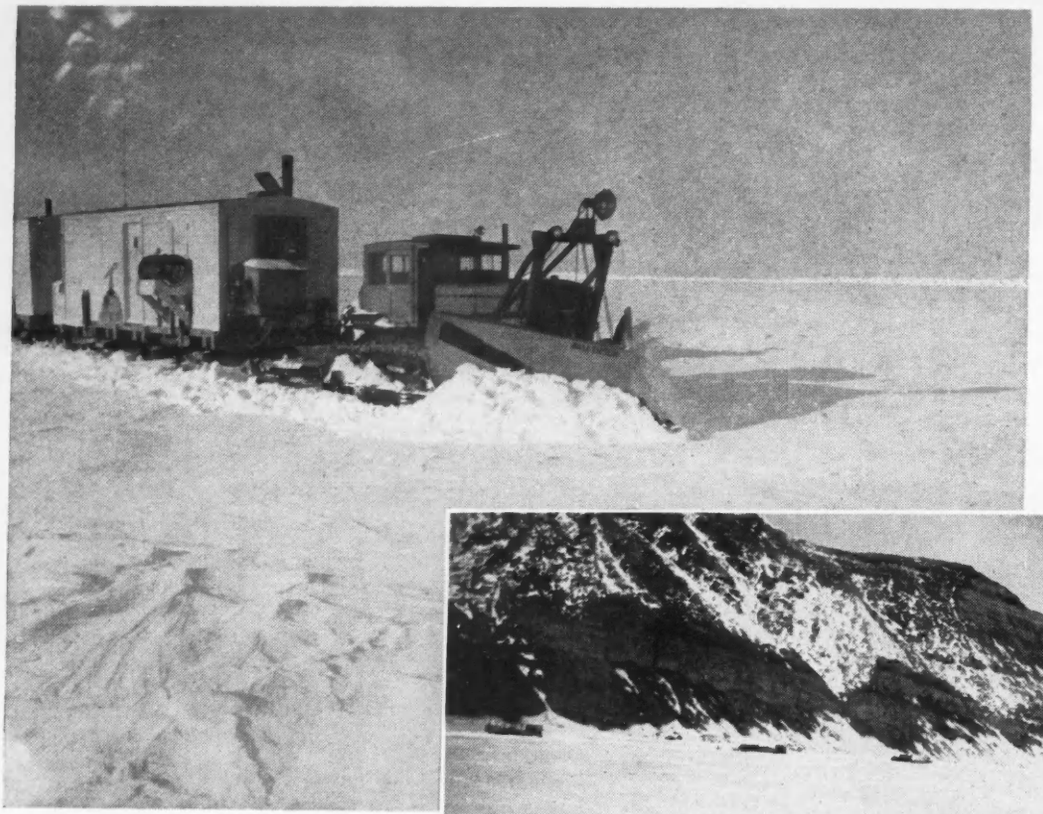


LEFT: Tractor with snow plow.

RIGHT: Train on Colville River.

TABLE 1
Lubrication Oils

SAE No.	Navy Symbol	Uses	Pour Point	Remarks
10	9110	Crankcase; tractors, weasels auxiliary equipment.	—30° F.	Heavy duty diesel lubricant.
20	9170	Crankcase; tractors, weasels, auxiliary equipment. Tractor transmission.	—10° F.	Heavy duty diesel lubricant used as SAE 20 in gears.
90	9500	Engine oil, also used as lube. in transmission, final drive of tractors. Weasel trans. & differential. Tractor track rollers.	0° F.	Used as SAE 50 in engine. Used as SAE 50 in gears.
140	5190	Tractor trans. and final drives	Above 0° F.	Not used in other equipment.
....	GO-75	Hyster winch	—20° F.	....

TABLE 2
Fuel

Fuel	Grade	Use	Pour Point
Diesel	40 Cetane	Tractors	—50° F.
Gasoline	72 Octane	Weasels, auxiliary equipment	Below —50° F.
Gascline	62 Octane	General Use	Below —50° F.

TABLE 3
Fuel and Lube Oil Consumption

	Operating Hours	Idling Hours	Gals. Gasoline	Gals. Diesel	Gals. Lube. Oil
Weasels	1192	....	1791	....	16
Tractors	11307	7527	....	58,670	904
Stove, Galley	3791	....	....	3000	....
Light Plant	3751	....	3535	....	18.5
Stove, Sleeper	3477	....	....	2358	....
	23,529	7527	5326	64,028	939

ing season of 1948 have superior cold weather characteristics to those used in previous seasons.

Fuels purchased for use in future freighting operations also have better cold weather characteristics. Previously 80 octane gasoline had been the standard fuel used in weasels and auxiliary equipment. This high lead content gasoline apparently caused heavy deposits of lead oxide to be formed in the lubricating oil. Also, heavy deposits of lead oxide were found on pistons and valves. It is thought that 80 octane gasoline possessed too high a lead ethyl content for use in extreme low temperatures. The use of 72 octane gasoline in future operations may prove this to be so, although sufficient data on its use have not been compiled to date to know whether the change will be an advantageous one.

Fuel and Lube Oil Consumption

Table 3 on fuel oil and lube oil consumption is for three tractor trains of five tractors each with the exception of one trip made when three trains totaling 19 tractors were used.

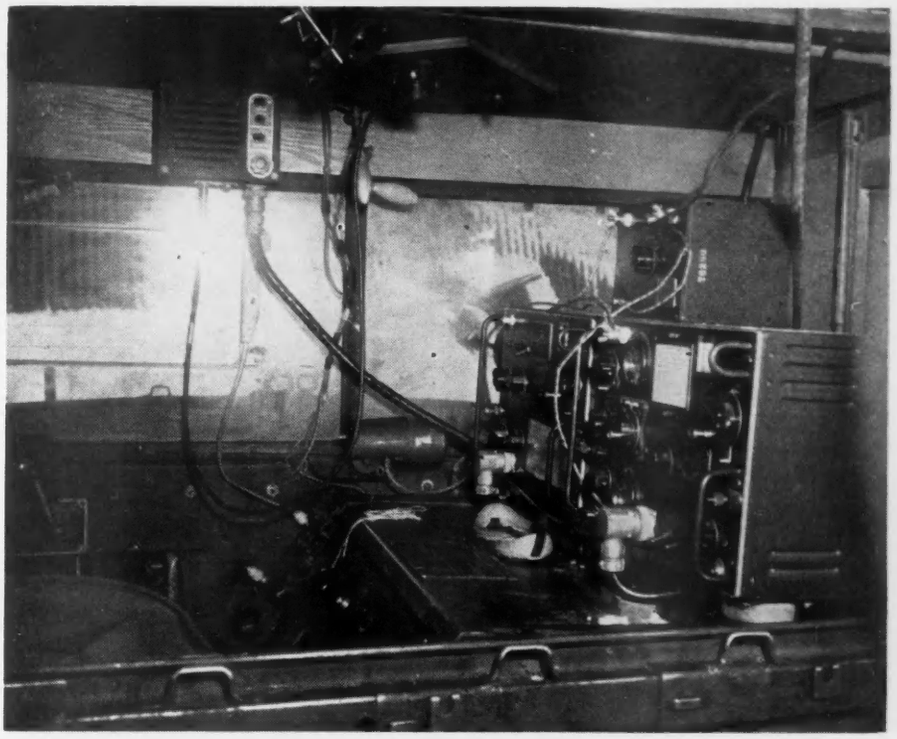
As stated earlier in this discussion,

three trains composed of five tractors were used. Each train operated as a separate unit. The total net tons hauled during the season were 5975, a total of 738,513 net ton miles. This work was performed between January 19, 1947, and June 12, 1947. Eighty-five percent of the freighting was completed by April 29, 1947, although it was necessary to freight supplies to a project site that was not initiated until freighting was considered completed.

Costs

The amount of $203,209.69 was expended on winter freighting in moving 5975 net tons at a unit cost of $0.27 a ton mile. It should be borne in mind that 85 percent of all freighting is done over ice which allows maximum loads to be handled by each tractor. Costs are broken into two sections, direct and indirect. Direct costs include labor, fuel, lubricating oils, and supplies. Indirect costs include depreciation of equipment, supervision and overhead calculated on direct charges.

These costs are exceptionally low as compared to freighting operations in other parts of Alaska and in Canada. This is a general average cost for an entire season's work, although it can be said that on some of the routes over which freighting is done, the cost may greatly exceed the amount given above and may reach a figure up to 75 cents or $1.00 a ton mile.



Weasel with transmitter and receiver installed. Looking through windshield.

ACKNOWLEDGMENTS

The credit for much of the pioneering work done by the U. S. Navy Seabees, and for guidance in later improvements during 1944 and 1945, must be extended to Captain Bart W. Gillespie, USNR (Inactive), as commander of the Seabee forces and now as project manager of the contracting organization presently engaged in the oil field exploration.

Thanks are extended to Commander George E. Fischer, USN, Officer in Charge of the Exploration Contract, and to Commander Palmer W. Roberts, USN, former Officer in Charge, under whose cognizance this work has been accomplished.

To Commodore William G. Greenman, Director, Naval Petroleum Reserves, thanks are extended for permission to publish this report.

TABLE 4

Tons Moved by Each Train

TRAIN	Net Tons	Ton Miles
1	1420	304,104
2	1101	225,839
3	3104	160,210
Misc. Trips	350	58,360
	5975	748,513

TABLE 5

Table of Costs—Three Five-Tractor Trains

Direct Costs

Labor, train crews (including labor charged to preparation for freighting)	$107,060.76
Fuel, including gasoline at 9 cents a gallon, 64,028 gallons	5,762.52
Lubricating oils, at 25 cents a gallon, 939 gallons	234.75
Supplies, including food	4,109.43
Sub-total	$118,167.46

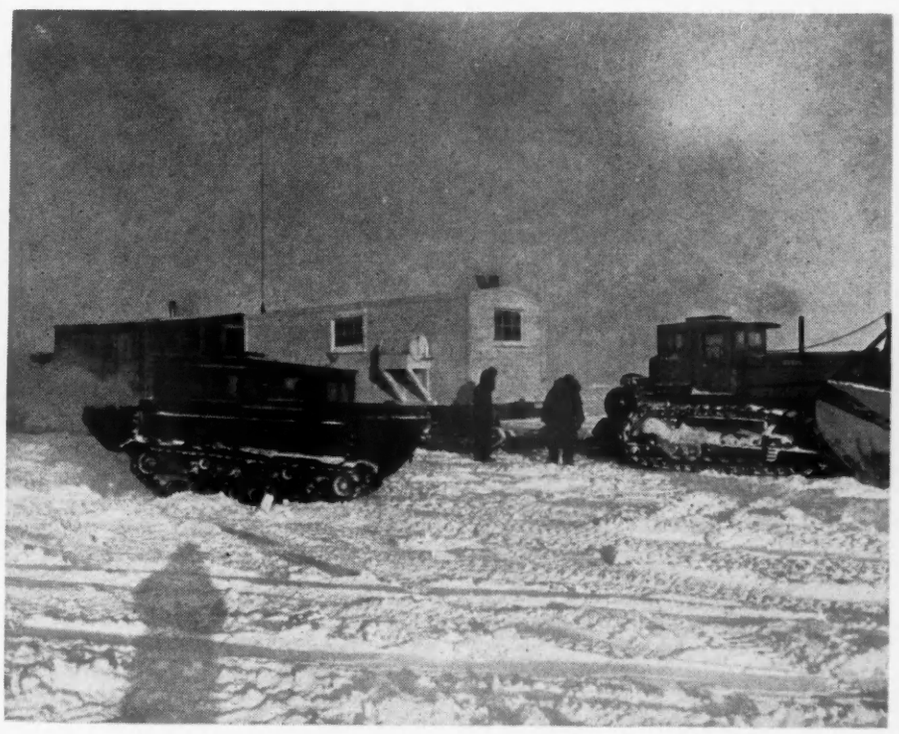
Indirect Costs

Depreciation charges:		
a. Tractors	$15,075.00	
b. Sleds	15,000.00	
c. Go-Devils	9,000.00	
d. Wanigans	4,500.00	
e. Weasels	1,450.00	
f. Miscellaneous Equipment	1,000.00	
Supervision	3,568.00	
Overhead (30 percent of Direct Charges)	35,450.23	
Sub-total	$ 85,042.23	
Total		$203,209.69

$$\text{Cost per ton mile} = \frac{\$203,209.69}{748,513} = \$0.27$$

NOTE:

a. 15 Tractors, estimated life of each—12,000 hours
b. 30 Sleds, estimated life—10 seasons
c. 30 Go-Devils, estimated life—10 seasons
d. 6 Wanigans, estimated life—4 seasons
e. 3 Weasels, estimated life of each—3000 hours
f. Miscellaneous Equipment—4 seasons.



Lead tractor with galley, sleeper wanigans and trail weasel.

Iran Line

to Be Completed This Year

A NEW pipe line from the Agha Jari oil fields in Iran to the Abadan refinery is expected to be completed this year and to make available an additional 100,000 barrels a day of oil for the U. S. Many industry economists and government officials consider the line the most immediately important foreign oil project anywhere in the world in terms of the amount of petroleum and the import delivery schedule it will make possible for this country during the shortage period directly ahead.

The new line will be laid by the Anglo-Iranian Oil Company, Ltd.; all pipe has been rolled and work will start just as soon as the Department of Commerce clears the export license for the steel. The line will consist of 56 miles of 20-to-22-inch welded steel pipe and 25 miles of eight-to-ten-inch seamless pipe.

Anglo-Iranian's main crude lines from Agha Jari, at the head of the Persian Gulf, pass within five miles of Bandar Mashur which connects with a terminal on the Gulf. There are now three lines from the field for the first 25 miles, after which a 12-inch fourth line connects into the system, crossing the flat desert by gravity flow. The present total capacity of this network is 170,000 barrels a day.

At a point nearest to Mashur, two 12-inch lines branch from the main system to feed a tank farm comprising five tanks each of 134,000 barrel capacity. At present, too, there exist tanker loading pumps and two mooring berths at Mashur which permit two large tankers to be loaded simultaneously at the rate of 3800 barrels an hour. The effective annual loading rate now averages 50,000 barrels per day.

When this take-off is substracted from the line capacity, another 120,000 barrels a day is carried on from Mashur to the Abadan refinery.

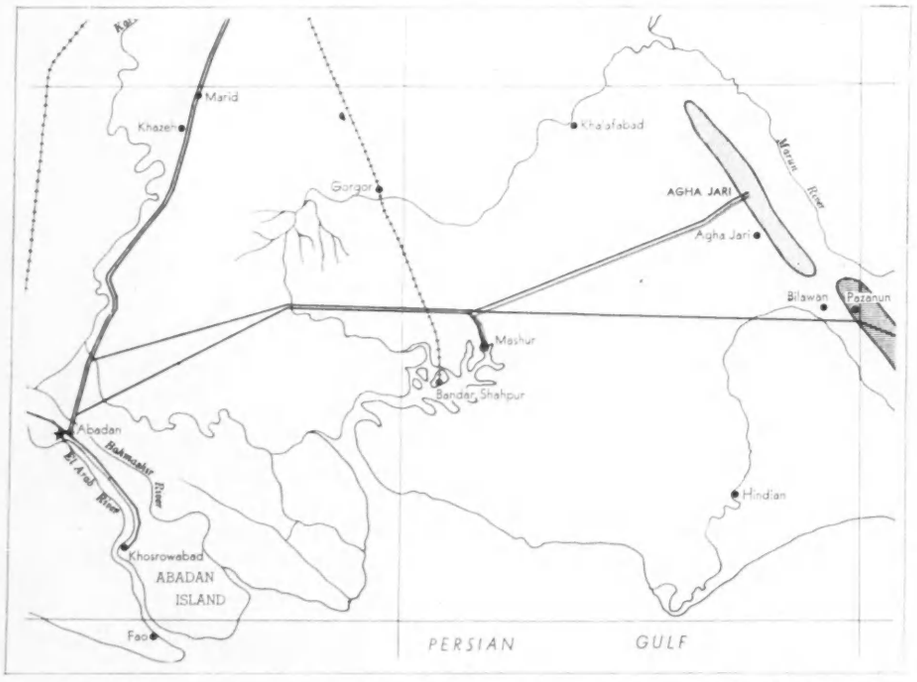
The new system will increase the throughput from Agha Jari to Mashur by 100,000 barrels a day and still allow the onward flow of 120,000 barrels daily for Abadan. All of the extra 100,000 barrels a day will be shipped to the U. S. East Coast for processing.

In addition to the line itself, Anglo-Iranian is expanding installations at Mashur. Seven new loading tanks are being placed, each of 134,000 barrels capacity; four new loading pumps, three loading lines, and two new mooring berths are being built so that four tankers will be able to load simultaneously, each at the rate of 7500 barrels an hour.

The entire project has required only 12,000 tons of steel in pipe from the United States and another 6000 tons from Britain for tanks, reinforcement and terminal fittings. This investment of steel, equaling one-eighth of a ton per barrel per day of oil, is believed to represent the greatest quantity of oil for the least steel anywhere in the world.

Anglo-Iranian has a drilling program in full swing at Agha Jari and will have the field fully drilled up this year to supply the new line. Agha Jari production will be stepped up next year from its current 160,000 barrels to around 320,000 barrels a day. The following table summarizes the field and pipe line projects:

	Barrels per Day	
	1948	After Jan., 1949
Agha Jari field crude production	160,000	320,000
Total pipe line capacity to Mashur and Abadan	170,000	350,000
Present crude supply to Abadan	120,000	120,000
Loading capacity at Mashur	50,000	150,000
Nominal flexibility factor	.....	80,000



Colored line indicates route of new construction paralleling present line from Agha Jari to Mashur.

The Socony-Vacuum Oil Company has signed a contract with Anglo-Iranian for 40,000 barrels a day of crude to be loaded at Mashur, and Anglo-Iranian has negotiations under way with five other U. S. oil companies to take the rest of the additional 100,000 barrels. The Socony-Vacuum contract is conditioned on completion of the company's Paulsboro refinery, work on which is scheduled to be finished by July 1, 1949. After January 1, 1949, and before July 1, 1949, Socony-Vacuum will take half of its contract tender, 20,000 barrels a day.

The entire project has been delayed several months due to failure of the Department of Commerce Office of International Trade to approve export licenses for the pipe already awaiting shipment. The project has been approved by the U. S. military, State Department, and other agencies, but has been held up on question of the Navy that sufficient tankers might be available to transport the crude.

Aeromagnetometer Profile

Flown from Venezuela to Texas

THE SUBJECT of aeromagnetometry has received much attention in the past few years. Many writers have published articles on various phases of the subject. This paper describes the results of a single flight across the Caribbean Sea and the Gulf of Mexico. No discussion of the methods of interpretation or of the instrumentation is intended.

By JAMES AFFLECK

FAIRCHILD Aerial Surveys, Inc., working under a contract with Gulf Research & Development Company, made a flight in an A-26 aircraft from Maracaibo in Western Venezuela to Kingston, Jamaica, and from Kingston to Brownsville, Texas. During this flight, magnetic records were made by means of the Gulf Research & Development Company's aeromagnetometer equipment being used by Fairchild.

The fundamental purpose of the flight was to return the aircraft to the U. S. for overhaul, and the taking of a magnetic record was incidental to this flight. For this reason, the aircraft was flown under best operational conditions and flight levels. The flight to Kingston was at an elevation of 8000 feet above sea level, and to Brownsville, 8500 feet, with an aircraft ground speed of approximately 240 miler per hour. If the main purpose of the flight had been to obtain magnetic data, a straight line flight, elevation about 2000 feet, passing directly over all terminal points, would have been requested. During the actual flight, changes of elevations and course were made according to normal flight procedure. The position of the aircraft and therefore of the magnetic anomalies, was obtained by dead reckoning. The data presented are therefore weak in respect to positioning and flight elevation, but the precision of the magnetic readings is about ± 2 gamma. No corrections were made for diurnal variation or for rather minor instrumental drift, the combined effect of which might be of the order of 50 gamma distributed over the extent of the profile.

Area Covered

Figure 1 is a small-scale map of the area traversed by the flight, with identi-

About the Author

JAMES AFFLECK has been with Gulf Research and Development Company since 1930, during which time he has been in the Magnetics Interpretation Section of the Geophysics Division. He is now in charge of the section. He holds a B.S. degree in electrical engineering from Carnegie Institute of Technology, and a M.S. degree in mathematics from the University of Pittsburgh. He is a member of the American Geophysical Union and of the Society of Exploration Geophysicists.

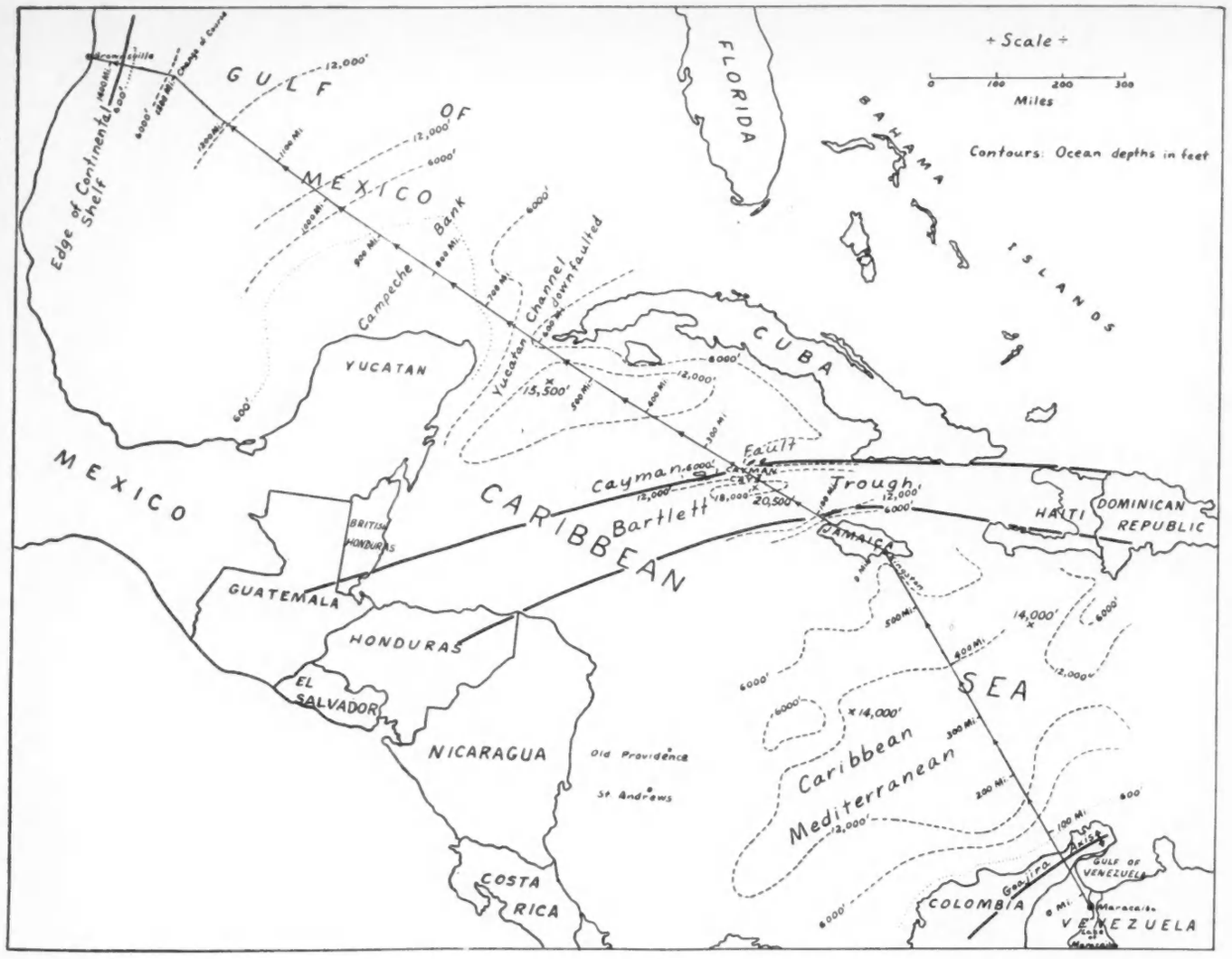


FIGURE 1. The Caribbean Area showing aeromagnetometer profile, geological features, ocean depths.

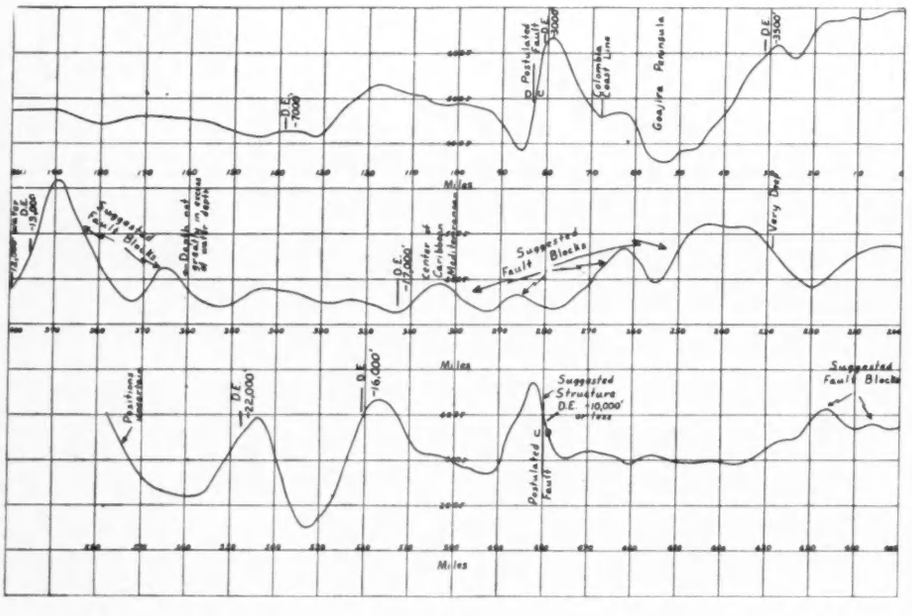


FIGURE 2. Magnetic total intensity profile, Maracaibo to Kingston.

fying mileage marks shown on the profile. Ocean depths are shown by dashed and dotted contours. Major geological features, as taken from Charles Schuchert's "Historical Geology of the Antillean-Caribbean Region," are also indicated.

Magnetic Curves

Figures 2, 3, and 4 give the magnetic curves at a horizontal scale of 20 miles to the inch and a vertical scale of 200 gamma per inch. The original records have been corrected for normal magnetic variation so that the curves should represent the relative anomalous total magnetic intensity. On many of the anomalies, subsea depths to magnetic igneous basement material were estimated, and these are shown on the curves and on the map in Figure 5. The origin of mileage coordinates is about 30 miles northwest of Maracaibo for the southern part of the flight and about 15 miles out from Kingston on the northern portion. The magnetic datum values for the two portions are independent. For ease in correlation between the curves and the

map, the abscissae increase from right to left, and all critical points are shown on the curves and on the map in Figure 5.

On the flight from Maracaibo to Kingston (Figure 2) sharply decreasing intensity was encountered for the first 50 miles. A depth estimate on a sharp anomaly at the 30-mile mark indicates that magnetic igneous material is about 3500 feet below sea level. The flight crossed the Goajira Peninsula where the surface elevation is everywhere less than 1000 feet, northeast of the high spur of the Andes, and the southwest of the mountain range which exists in the eastern part of the peninsula. Unfortunately, no anomalies suitable for depth calculations are present in this region.

Strong Magnetic Anomalies

Near the Colombia coast, rather strong magnetic anomalies are found. At the 80-mile mark, a sharp feature suggests a strong fault, depth to the upthrow side of which seems to be of the order of 3000 feet subsea, and this fault may constitute the southern boundary of the Caribbean Mediterranean Sea. Near the 140-mile mark the depth seems to be about 7000 feet to magnetic basement. Beyond this feature, the basement must be composed of fairly homogenous material out to the 200-mile mark. From the 230- to the 310-mile mark, sharp anomalies suggest the presence of horsts and grabens, and the only depth estimation indicates 17,000 feet subsea at 310 miles. This may be near the center of the Caribbean Mediterranean and suggests no great thickness of sedimentary rocks over the basement. At 360 to 420 miles, another group of anomalies suggest fault blocks, on one of which a depth of about 13,000 feet is suggested while the water depth is 12,000 feet. From 420 to 480 miles, only minor anomalies exist. At 480 miles, a 170-gamma anomaly gives a depth perception of 10,000 feet and suggests a substantial fault, downthrown to the south.

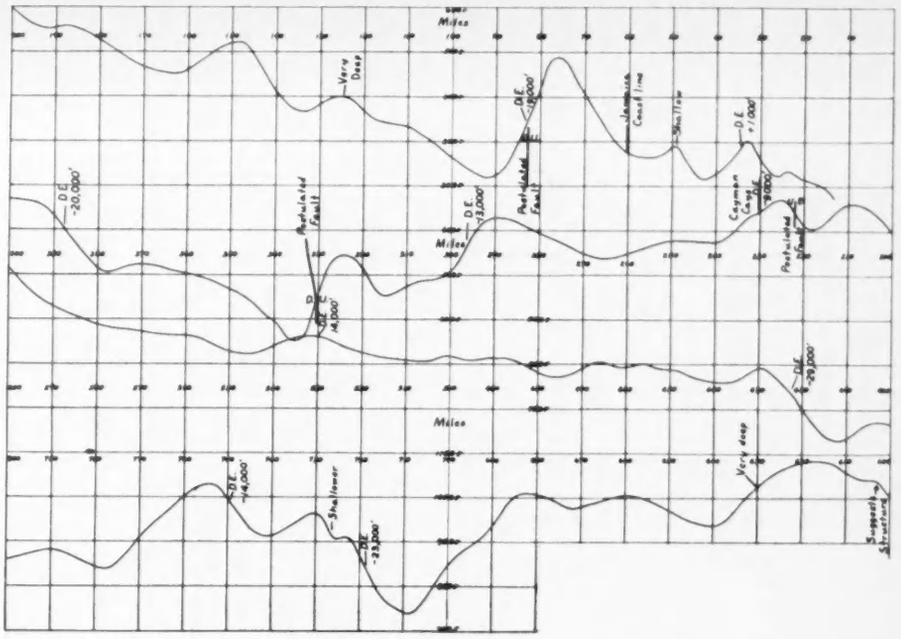


FIGURE 3. Magnetic total intensity profile, Kingston to Brownsville (part 1).

Beyond this feature, strong smooth anomalies suggest greater depths, the greatest being about 22,000 feet. The presence of an area of deep basement separated from the Caribbean Mediterranean by a shallower mass at the 480-mile mark is thus postulated. Unfortunately, the anomalies near the southern coast of Jamaica cannot be used for analysis, since the aircraft was changing elevation and direction rapidly during the approach to the air field.

Kingston Area

After the take-off from Kingston, the aircraft elevation increased rapidly. In passing over the island, an anomaly was found which indicates that the magnetic basement may extend to 1000 feet above sea level. At the 80-mile mark, a strong anomaly suggestive of a large fault downthrown to the northwest gives a depth estimate of 19,000 feet subsea which suggests the southern edge of the Bartlett Trough. Northwestward of this fault to the 220-mile mark, the intensity shows a strong increase of a regional nature, and the impression of very great depths to magnetic basement is gained. At the 220-mile mark, an anomaly is interpreted as being caused by a fault at approximately 9000 feet subsea, which correlates closely with the Cayman Fault at the northern edge of the Bartlett Trough. At 300 miles an anomaly yields a depth of the order of 13,000 feet, and at 330 miles another strongly suggests a fault at 14,000 feet. Beyond this point much greater depths are indicated. A high area, separating the Bartlett Trough from the deep which is sometimes called the Antillean Sea or the Cuban Sea, is therefore recognizable. In the Antillean Sea, two depths of 20,000 feet at 390 miles and 29,000 feet at 420 miles are indicated.

Beyond these features an area containing only small anomalies is present. At 530 miles, a shallow mass (14,000 feet) is postulated which may correspond to an ancient connection between Yucatan and Cuba, or it may be an expression of the submerged portion of the Cuba uplift. At 600 miles a sharp anomaly suggests structure, and at 630 miles a feature suggests very great depth, probably in the downfaulted Yucatan Channel. Between 630 miles and 700 miles no depths could be obtained. Between 700 miles and 780

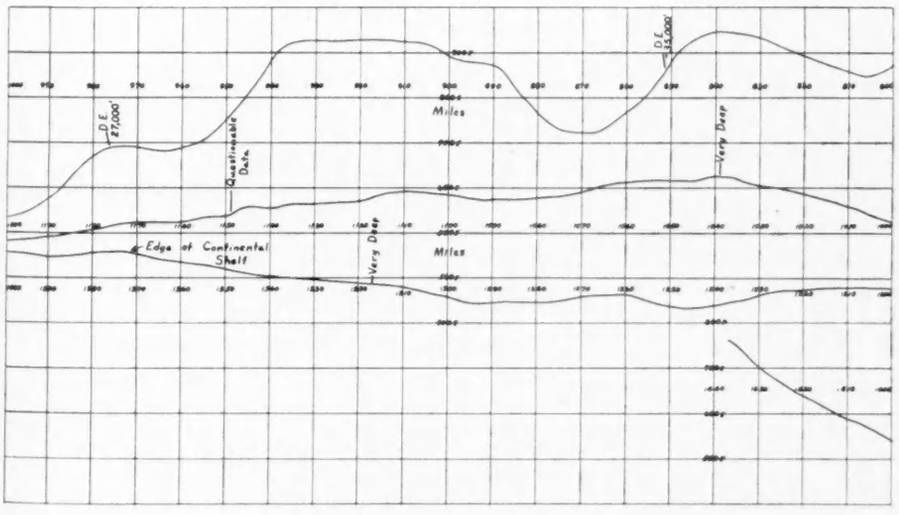


FIGURE 4. Magnetic total intensity profile, Kingston to Brownsville (part 2).

FIGURE 5. The Caribbean area showing aeromagnetometer profile, and calculated subsea depths to magnetic basement.

miles there are strong positive anomalies possibly derived from varying depths. These are 23,000 feet at 720 miles; shallower at 725 and 730 miles; 14,000 feet at 750 miles. This group may correspond to the Campeche Bank. Beyond this area the great depth values obviously correspond to the Gulf of Mexico deep. At 850 miles, 35,000 feet is obtained. Between 880 miles and 950 miles there is a strong magnetic high zone, which must correspond to a change of magnetization in the basement rocks as do many of the other strong anomalies along the flight line. No depths could be obtained in this zone other than the impression of very great depths. At 980 miles, 27,000 feet is indicated, and beyond this point, for about 500 miles to the 1370-mile mark, only gentle anomalies, suggesting great depth, exist. At 1370 miles, a positive feature may indicate structure associated with the edge of the Continental Shelf.

It should be apparent that the results of this flight can be correlated closely with the known geology. Some additional details such as possible fault locations and the postulated deep south of Jamaica are offered. However, it is necessary to indicate the inherent dangers involved in making an interpretation from a profile of this nature. A profile gives only a single dimension viewpoint over an anomaly. If the profile crosses the anomaly near its apex and perpendicular to its axis, then depth estimates have some significance. If the profile is at a substantial angle to the anomaly axis, errors of 30 percent in the apparent depth may be involved, the errors being in the direction of excessive depths.

Added Uncertainty

The airplane height of 8000 or 8500 feet above sea level, plus ocean depths up to 15,000 feet or more, causes an additional source of uncertainty. As an example, if the aircraft is 23,000 feet above the ocean floor and the magnetic basement is 3000 feet below the ocean floor, the total depth to magnetic material is 26,000 feet. A 20 percent error therefore causes a discrepancy of 5200 feet in the thickness of the sedimentary zone. If the aircraft were flown at 1000 feet to 2000 feet above sea level, the error would be substantially decreased.

It may be practical in the near future to have one or more profiles flown across the Atlantic or other oceans. Without question, the interpretation of these flights should contribute valuable information concerning the depths to magnetic basement. Other profiles have been made on cross-country flights. When these are assembled and interpreted, not only will approximate depths to magnetic basement be determined, but conditions within the basement relative to mountain building may be found.

This project suggests a manner in which interesting and valuable geologic data can be secured incidental to other operations not directly involved in geophysical surveys. The extra care and planning involved were capably handled by the personnel of Fairchild Aerial Surveys, Inc., under the direction of M. A. Phillips of that company. However, the author accepts full responsibility for the interpretation of the data.

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Better Terms Expected For U. S. Capital in Mexico

Current negotiations between Mexico's state oil monopoly, Petróleos Mexicanos (Pemex) and several American companies are expected to result shortly in announcement by the Mexican government of more favorable terms for the enlistment of U. S. capital and skills in Mexico's oil development program.

Two issues still remain unresolved: (1) legal restrictions on the amount of stock ownership non-Mexican nationals may hold in companies formed to explore and drill in Mexico; (2) the proportion of oil discovered that may be taken by American concerns operating in Mexico. Pemex has virtually conceded that American operators may claim up to 80 percent of all newly discovered oil to the amount of capital investment in a project; but thereafter Pemex is unwilling to write 50 percent "take" into pending contracts. Mexico's first contract less than a year ago, with J. Edward Jones, was a straight cost-plus-10-percent deal. Since then Pemex has learned that American capital and know-how generally will not be attracted by such a proposition and has liberalized the offers made to Cities Service and pending with The Texas Company.

The details of these later contracts have not been announced, but the Cities Service arrangement is reported to include a provision for a $10 million loan to Mexico with the company ultimately purchasing 50 to 80 percent of discovered oil. (See World Oil, May, 1948, page 282). The Texas Company deal, which has not yet received final approval, is termed by one Pemex spokesman a "barter plan" by which Texaco supplies Pemex not with cash loans but with equipment and material for such projects as the Tehuantepec Isthmus pipe line and completion of the Salamanca refinery.

One difficulty now appears to reside in the "exportable surplus" offers of Pemex; several industry authorities believe that Mexico already has "oversold" its exportable surplus and that until new oil is actually discovered there is no "take" possible for any American concerns. This snag is reported to be holding up the Texaco deal after Pemex realized that it might not be safe to commit any existing exportable surplus to Texaco because 1948 production increases are not materializing. Another reported proposal to Pemex by Glenn McCarthy is said to be stymied for the same reason since it was tied in with option on some of Pemex's current production.

Still another drilling arrangement is under negotiation between Pemex and Southeastern Oil de Mexico, of which Gordon Duke has lately retired as president, being succeeded by General Manuel J. Zevada, an outstanding petroleum and mining engineer and for ten years general supervisor of gas and oil for the Mexican Government, and also associated with Pemex in charge of expropriated refineries.

Dairio Oficial de la Federació of Mexico on May 18 published the text of an agreement concluded between Cities Service and Pemex covering indemnity payments to the affiliate companies Mexico-Texas Petroleum and Asphalt Company and Sabino Gordo Petroleum Corporation. In compensation to these companies for properties affected by the expropriation order of 1938, the agreement provides that Mexico shall pay the companies $1 million in U. S. money as follows: $200,000 to Sabino Gordo on January 1, 1949; $200,000 to Mexico-Texas on January 1, 1950; $200,000 to Compañía de Terreños Petroliferos Imperio, S.A., on January 1, 1951; and $400,000 to Mexico-Eastern Oil Company. The last-named payment is to be in two installments, each of $200,000, payable January 1, 1952, and January 1, 1953. In return for this, the Cities Service companies have agreed to waive any rights they may have had in the former properties, either under Mexican or international law.

French Refineries Average 4,200,000 Barrels Monthly

French refineries have processed an estimated 20,720,000 barrels of crude oil in the first five months of 1948, bringing the monthly average throughput up to 4,200,000 barrels in 1948 as compared with 2,975,000 barrels in 1947.

Improved freight and foreign currency conditions may increase refinery output for the whole of 1948 to 56 million barrels. In 1947, a total of 35,630,000 barrels were processed.

Polish Crude Output Reaches 2697 Barrels Daily in March

The output of the Polish industry in March, 1948, totaled approximately 83,620 barrels of crude oil or 2697 barrels daily. Approximately 596 million cubic feet of natural gas were produced in the period. The crude production was more than 5 percent and gas more than 1.6 percent above the goal set by the government.

The increase in crude production was attributed to the completion of a new well at Foulsz near Gorlice. More than 17,535 feet of hole were drilled during March, 3680 feet of which were drilled in wildcat holes.

Polish refineries had a throughput of 132,662 barrels of crude oil, of which 80,482 barrels were domestic and the remainder imported.

Yugoslavia Exceeds Production Goal by 14 Percent in 1947

Reports from the Yugoslavian oil and gas industry indicate that it has overfulfilled its production plans by 14 percent in 1947. The Five Year Plan inaugurated last year calls for an output of 3,150 000 barrels of crude oil in 1951 but does not specify goals for the intervening years.

New Italian Field Produces 105,000 Cubic Feet of Gas Daily

A new Italian field, whose reservoir is estimated to contain several billion cubic feet of methane gas, has been discovered between Ravenna and Ferrara. Approximately 105,000 cubic feet of gas are being produced daily from a zone between 1500 and 1800 feet, and plans are being completed to connect the field to Bologna.

Other small natural gas deposits have been discovered recently in Modena Province, yielding about 35,000 cubic feet a day.

The Italian Government has removed restrictions on the import of plant and equipment for the natural gas industry and has also removed all restrictions on sales of methane gas.

Wildcat in Northeast Spain Still Unsuccessful at 8500 Feet

Wildcat drilling to a depth of approximately 8500 feet at Oliana in the Province of Lerida, or Catalonia, in northeast Spain, has been unsuccessful and heavier drilling equipment has been installed. It is believed that the prospects for deeper oil in this area, and also in the Alicante region of southeast Spain, are promising.

ISOLATING CASING

SALT WATER DISPOSAL

ACIDIZING

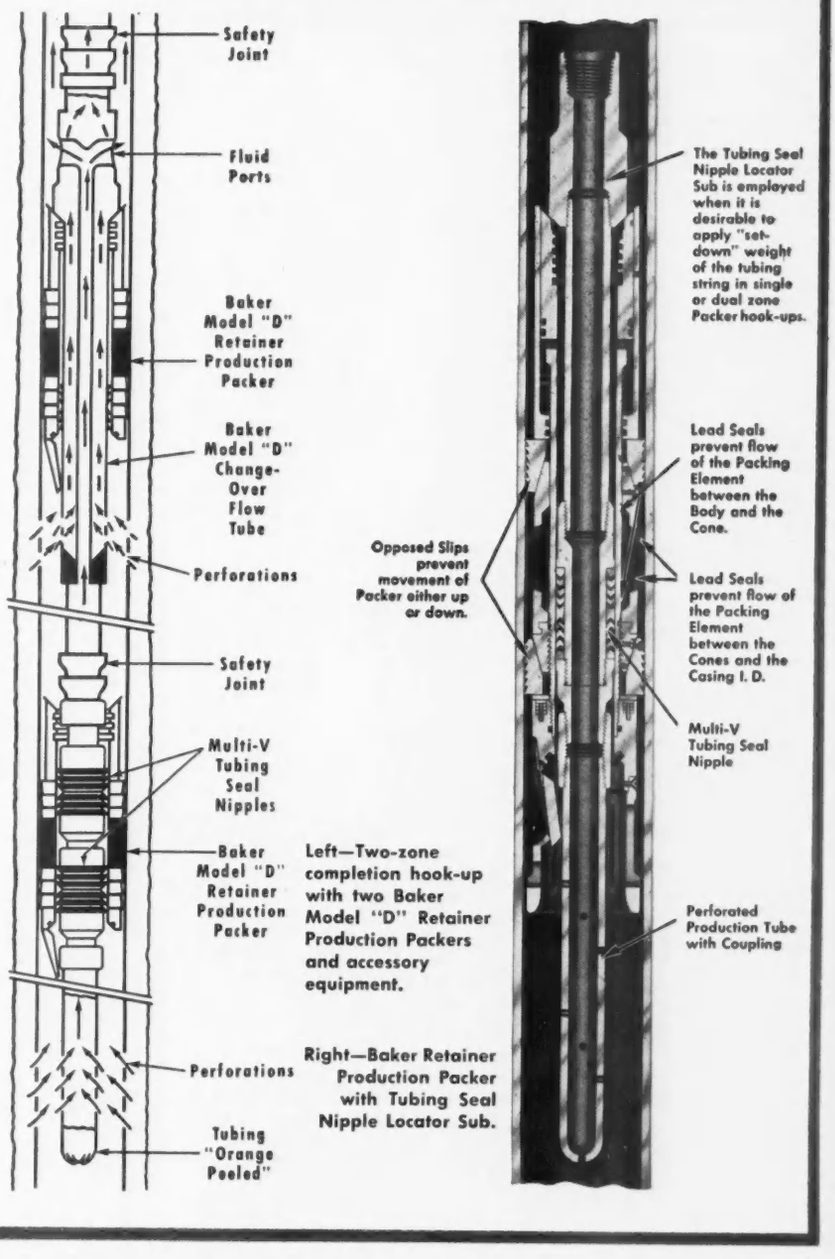
RE-PRESSURING

CAN PERFORM THEM SUCCESSFULLY

wide popularity because of its effective application to many needs in producing wells. It can be set and used for making a flow test, utilizing the Packer for production through the tubing, if the zone proves productive. If not productive, the zone can be squeeze cemented through the Packer. One Packer provides for production of two zones, either simultaneously with segregated production, or from each zone separately at different times. For complete flexibility of two-zone production, a Baker Change-Over Flow Tube (see illustration) with two Packers may be used. For three-zone production only two packers are used.

The Baker Retainer Production Packer is used for single-zone installation to prevent gas from cutting holes in the casing (often started by thread leaks) by transferring the pressure from the casing to the tubing. If and when the tubing leaks, it can be pulled, repaired and replaced through the Packer. The Packer will protect the casing, when corrosive fluid is being produced or injected, by allowing the annulus to be filled with oil and confining the corrosive action to the tubing only.

An interesting use of the Baker Retainer Production Packer is for pumping or flowing an upper zone through the tubing, and flowing a lower zone through the annulus between the tubing and the casing. This hook-up calls for use of the Baker Change-Over Flow Tube, and in addition to permitting segregated production as mentioned above, production of both zones through the tubing may be secured without removing the tubing string from the well.


Safety Joint
Fluid Ports
Baker Model "D" Retainer Production Packer
Baker Model "D" Change-Over Flow Tube
Perforations
Safety Joint
Multi-V Tubing Seal Nipples
Baker Model "D" Retainer Production Packer
Perforations
Tubing "Orange Peeled"
Opposed Slips prevent movement of Packer either up or down.
The Tubing Seal Nipple Locator Sub is employed when it is desirable to apply "set-down" weight of the tubing string in single or dual zone Packer hook-ups.
Lead Seals prevent flow of the Packing Element between the Body and the Cone.
Lead Seals prevent flow of the Packing Element between the Cones and the Casing I. D.
Multi-V Tubing Seal Nipple
Perforated Production Tube with Coupling

Left—Two-zone completion hook-up with two Baker Model "D" Retainer Production Packers and accessory equipment.

Right—Baker Retainer Production Packer with Tubing Seal Nipple Locator Sub.

GET ALL DETAILS

If you have any production problems which might be solved by the use of a Baker Model "D" Retainer Production Packer, we suggest you contact the nearest Baker representative; or address mail inquiries to Baker Oil Tools, Inc., Box 2274, Terminal Annex, Los Angeles 54, California, U.S.A.

BAKER OIL TOOLS, INC.

Houston · Los Angeles

New York

Retainer Production Packer

Product No. 415-D

ATTEND NOMADS MEETING—Seated, left to right, are Arthur S. Osborn, Arabian-American Oil Company; Ernest E. Woodbury, Richmond Exploration Company; and Irvin LaGrande, Drilling & Exploration Company. Standing, left to right, are R. H. Hume, Sinclair Oil Company; Lewis W. Miller, Texas Petroleum Company; and Douglas Pickard, Anglo-Iranian Oil Company.

Production in Mexico Reaches 56,130,255 Barrels of Oil in 1947

Final tabulation of production figures for Mexico in 1947, including late reports from some of the Isthmus fields, shows that Mexico produced 56,130,255 barrels of oil, for a daily average throughout the year of 153,782 barrels. Although 14.4 percent higher than production for 1946, it still is falling short of supplying any great surplus for export, and unless the Petróleos Mexicanos goals are met for the next few years, there will be a necessity for importing products. The 1948 program scheduled by Pemex calls for a daily average of 171,981 barrels, or 11.8 percent more than 1947. The Poza Rica field is to be called upon for a substantial amount of this, the schedule being 96,129 barrels a day. In anticipation of the continuing need for heavy demands on the Poza Rica field, a complete study is being made of a gas repressuring project for the area in an effort to bolster reservoir efficiency.

Egyptian Ministry Announces Data on Oil Field Concessions

Data relating to the three main concessions granted to Anglo-Egyptian Oilfields, Ltd., have been announced by the Egyptian Ministry of Commerce and Industry.

The Ras Gharib concession with 126 wells is producing 9 million barrels yearly; Ras al Sudr with five wells is producing 1,850,000 barrels yearly; and El Asl has 1 well, shut in.

The Ministry has also drawn up a bill authorizing the company to exploit the Sudr concession. The bill provides that the concession will be for 30 years and renewable for another 15 years; that the company will pay the government a tax equal to 14 percent of the value of the oil produced; and that the government will have priority in buying 20 percent of the production.

The Egyptian Government holds 100,000 shares in the company, giving it the right to 5 percent of the net profit of the company and 10 percent of all surplus profits.

India and Pakistan Announce Petroleum Concession Policy

The governments of India and Pakistan have announced their policy on petroleum concessions within their borders.

The government of the Dominion of India has decided to let existing oil concessions develop for a period of ten years and allow for this time all facilities for efficient working and reasonable expansion. At the end of this time the situation will be reviewed and the state may decide to acquire a unit after payment of just compensation.

Pakistan announced its wish to develop mineral resources, including oil. Industrial development is to be left to private enterprise. Foreign capital will be welcomed, providing that Pakistan nationals are allowed to participate in the administrative and technical departments and that opportunity will be offered to local capital.

Production in Vogelkop Region Likely to Be Resumed in 1949

The New Guinea Petroleum Company has announced that petroleum production in the Vogelkop region of Dutch New Guinea is likely to be resumed in 1949.

Exploratory tests will be drilled to a depth of 10,000 feet. Two rigs are to be put into service by the end of 1948 and an increasing number next year. Geological, gravimetric and seismic parties have started on detailed reconnaissance operations.

Burmah Oil Company Reports Rehabilitation Expenditures

The Burmah Oil Company has reported expenditures of £2½ million to defray rehabilitation expenditure on its Burma properties destroyed in 1942, for which the company is still awaiting compensation. Reconstruction of the properties will necessitate further large expenditures, another three years being expected to elapse before oil fields, pipe line, and refinery will all be in operation. The planned scale of operations will be less than before the war and will be conducted jointly with the Indo-Burma Petroleum Company and British Burmah Petroleum Company.

In the past the company has spent large sums on geological work and testing of new areas without return, but is preparing to make further examination of possible territory as soon as the terms of prospecting licenses and leases have been fixed. Discussions with the government of the new Union of Burma are now being held. The government is formulating a policy on the future granting of oil concessions, since the development of all natural resources in Burma is subject to nationalization after fair compensation to owners.

The company's exploration plans include areas in Pakistan and India, but are subject to the securing of reasonable terms, especially in regard to security of tenure, with the governments concerned.

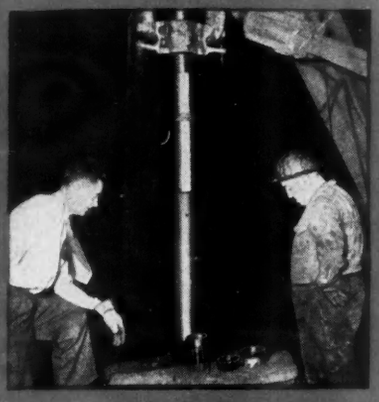
Netherlands Expects Increase In Production and Refining

In the fields of both petroleum production and refining, the Netherlands is anticipating increased activity during the remainder of 1948. Oil production in the Schoonebeek field of northeast Holland has nearly doubled since the beginning of the year and is now equivalent to approximately 2,800,000 barrels annually. The number of pumping wells is 46, with the high wax content of the crude causing production difficulties. Considerable increase in production is expected as more wells are drilled. A recent announcement made by the government stated that 44 out of 48 wells drilled near the field were successfully producing oil, and that exploratory drilling was under way at Delft, Coevorden (on the German border) and Zaandam.

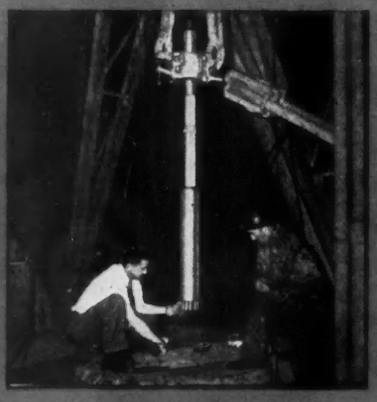
An agreement between Germany's Wintershall Company and the Nederlandsche Aardolie Maatschappij as to spacing of the Emlichheim-Schoonebeek field should insure rational development of the structure.

Crude from the field is sent to Pernis, near Rotterdam, by rail to be refined in Bataafsche Petroleum Company's plant, whose processing capacity at present is almost 20,000 barrels a day. The com-

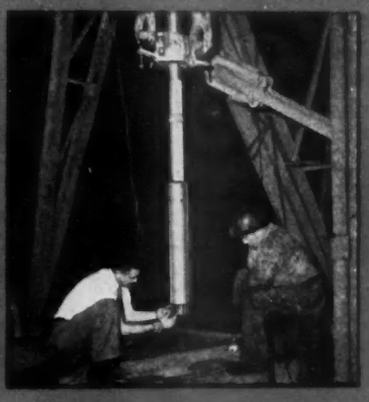
COOPER DIE-FORMED BASKET



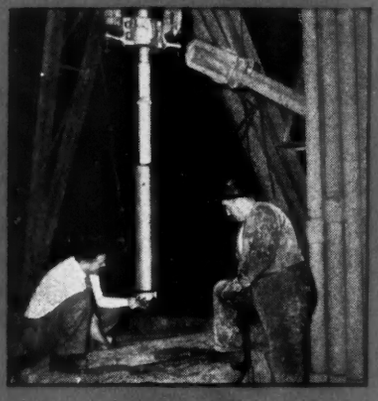
Lift with Elevators



Insert Basket Fingers

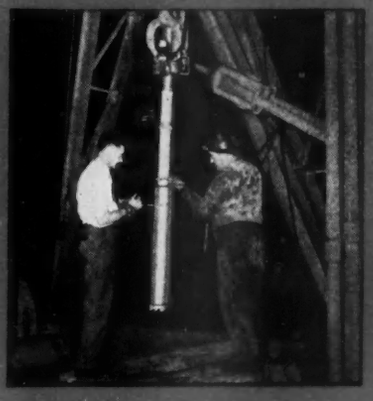


Insert Die Ring



Screw on Shoe

Tighten Shoe



Insert Shear Pins

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- The Cooper Die-Formed Basket needs but one shot at your fish.
- In six simple fast steps it's ready to run.
- Run the Basket to the bottom, rotate a half dozen times, apply weight and the Basket Fingers scrape the bottom of the hole, intermesh, and enclose all the junk in a tight steel basket.
- No need to make hole. Less than three minutes on the bottom and you've got your fish.
- The diameter of Basket Shoe doesn't have to be the exact diameter of the hole for successful operation.

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pany (a subsidiary of Royal Dutch Shell Group) is planning extensive additions to the plant to be completed in 1953, upping its capacity to approximately 57,500 barrels a day. Installations have already been built for the production of chemical products in a plant adjoining the Pernis refinery.

The increased capacity will necessitate not only erection of new factories but also the extension of auxiliary and subsidiary installations. The tank farm will be enlarged and at least three new jetties built to berth sea-going tankers and canal barges. The refinery is situated on the left bank of the canal, opposite Vlaardingen. When the plans have been fulfilled the refinery will cover a total area of 850 acres.

Production Partly Resumed In Vicinity of Leduc Well

Near the end of June the operation of disposing of the surplus oil produced from the Atlantic wild well in the Leduc field had progressed to the point where partial resumption of normal producing operations in the remainder of the field could be allowed.

Although the well is still out of control and producing an estimated 6000 barrels daily, much of the surplus oil has been picked up and transported through Imperial's pipe line to Nisku. During the emergency the line has been handling an average of 12,000 barrels daily which is being moved from Nisku by tank car. At the same time transportation by truck has been stepped up and an estimated movement of 2000 barrels daily by that means has been achieved, so that despite an emergency that caused a complete shutdown in the field for a while, a new production peak is being reached. The wells other than the wild well are being allocated about 7000 to 8000 barrels a day on a restricted basis.

The Petroleum Board in charge of control operations on the wild well has allocated 6000 barrels daily as net production from that well. If production exceeds this amount the surplus is to be pumped back into the formation through Atlantic's No. 1 well on the same lease. Several thousand barrels have already been pumped into this well. Imperial, due to the impossibility of separating the weathered oil produced from the Atlantic 3 from live oil currently produced from other wells, is purchasing all of the output and allocating it to other refineries, on the basis of normal production and purchasing percentages.

Meanwhile, two relief wells were being drilled, one to the east and another south of Atlantic 3, and Imperial's 48 is being used as a water injection well, pumping water into the formation at a rate of about 40,000 barrels daily.

Shell Oil Company of Canada To Begin Drilling Near Sussex

Shell Oil Company of Canada, Ltd., plans to start drilling operations at a point about ten miles east of Sussex, New Brunswick, Canada. Other drilling operations have already been started near Moncton, New Brunswick, by New Brunswick Oilfields, Ltd.

The two companies are working in a 10,000-square mile area which is under crown lease to New Brunswick Oilfields, Ltd., successor to New Brunswick Gas and Oil Fields, Ltd. The new firm, a combination of Canadian and American interests, took over the business of the Scotch firm in June, 1947.

The New Brunswick management has started drilling operations at Round Hill, five miles from the nearest limit of Stony Creek field, in the easternmost gas and oil producing region of continental North America. A program is also being developed for modernizing the equipment and techniques used in Stony Creek field, which has not been produced in keeping with the latest developments in petroleum engineering.

House Committee Recommends Funds for Alaskan Exploration

The House Appropriations Committee has recommended allocation of the sum of $14,600,000 to be used in continued exploration of Naval Petroleum Reserve No. 4 in Alaska. With continued exploration and drilling of three wildcat wells, one of which is not yet completed, information is being coordinated for a still more intensive search for reserves of oil in that area. The new program reported to the appropriations committee calls for drilling of seven additional wildcat wells, at the same time carrying on the program of geological and geophysical investigation. In drilling the first two wells, considerable oil showings were found, but none have proved to be of commercial value.

Political Disturbances May Halt Middle East Pipe Line Activity

Continuation of political disturbances in the Middle East has caused withholding of export licenses for steel intended for use in construction of the important Trans-Arabian Pipe Line Company's line from Persian Gulf fields to the Mediterranean. Meanwhile, construction has proceeded on the lines connecting both Abqaiq and Abu Hadriyah fields with Qatif Junction so that more crude can be made available from these fields to a shipping point on the Gulf. These lines have now been completed.

There has been a considerable amount of discussion as to whether Trans-Arabian will continue with its plans for the big line, and it is thought not unlikely that construction might be postponed indefinitely unless there is a radical change in the situation in the entire Middle East. At this stage such a decision rests as much with the State Department as it does with the company making the expenditure.

Under such conditions, and should the line to the Mediterranean be shelved, it is not unlikely that a similar course will be pursued by the Middle East Pipe Line Company. This company, formed to build a line from Abadan to the Mediterranean, has not yet been activated and abandonment of plans for the line would not entail any substantial loss in outlay.

Production of Oil in Venezuela Continues to Top 1947 Level

Venezuela's production continues at a rate about 10 percent above the rate at which it produced for the year 1947. During the first four months of 1948 the nation produced 157,142,040 barrels of oil, and although the average was slightly less in April than in March, indications were that the upswing in producing rates would continue.

During April production amounted to 39,065,868 barrels, a daily average of 1,303,196 barrels, to compare with the daily average of 1,208,011 barrels maintained during 1947. Creole Petroleum Corporation continues as the largest single producer in Venezuela or the world, contributing an average of 679,242 barrels daily to the April total.

Ray Dudley Speaks to Nomads At June Meeting in Houston

Ray L. Dudley, president of Gulf Publishing Company, was the principal speaker at the June meeting of the Houston chapter of Nomads. In his talk he summarized conditions in the petroleum industry throughout the world, pointing to the sharp increases in demand for all kinds of petroleum products. He predicted tremendous expenditures by the industry during the next few years in order to meet demands, saying that the industry will spend half as much during the next few years as it has spent during its entire history to date. He briefly reviewed world developments during the past year, giving figures on production, completions, footage drilled, and number of rigs running in all active countries.

A number of guests from foreign fields were present at the meeting. They included H. Giordano of the Argentine Y.P.F.; E. Gastaldi, B. C. Berardinelli, and E. P. Ospital, all of Y.P.F.; Harry Simons, A to Z Export Company, Caracas; Bob Kuss, Mene Grande Oil Company, Venezuela; C. W. Daniel and A. E. MacKay, Shell Group, and Dan Moriarty, Creole Petroleum Corporation, Venezuela.

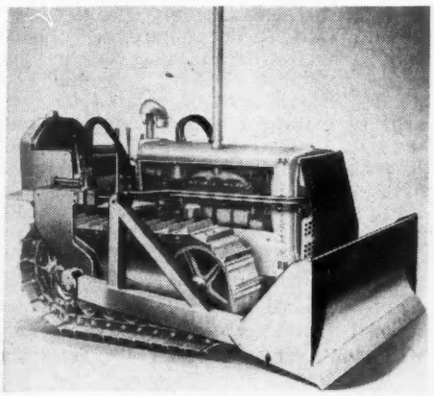
NEW AND IMPROVED Equipment SUPPLEMENTING COMPOSITE CATALOG

New and improved equipment of manufacturers who describe their products or services in the current Composite Catalog

76—Bulldozers

This item supplements the Caterpillar Tractor Company's data as shown on pages 994-995 of Composite Catalog.

Two hydraulic-controlled bulldozers have been designed for use with, and matched in capacity to the power of, the Diesel D2 tractor. They are the No. 2A, angling blade, and the No. 2S, straight blade, rounding out the line of bulldozers manufactured by the Caterpillar Tractor Company for exclusive use with their diesel track-type tractors.



The bulldozers combine the accepted blade features of the "Caterpillar" bulldozer family, both cable controlled and hydraulic controlled, and the advantages of a closed hydraulic system.

This system incorporates such features as front-mounted, positive-action, balanced vane type pump, integral with tank and operating valves; manually-operated control valve, with "raise," "lower" and "hold" positions; carburized pins for connecting pistons, cranks and push arms; high-pressure reinforced hydraulic hose; seamless steel lines coupled to hydraulic hose to direct oil flow from the hydraulic pump housing to the power cylinders.

The No. 2A bulldozer has a blade length of 80 inches for the 40-inch gauge D2 tractor and 97½ inches for the 50-inch gauge tractor. It has a maximum life, with blade straight, of 28 inches, or the front point of the blade with lift 32½ inches for the 40-inch gauge and 34 inches for the 50-inch gauge when the blade is angled but not tilted. It has an 11-inch drop below the ground, a blade angle of 25 degrees and a maximum tilting adjustment of six inches.

The No. 2S bulldozer, offered also for the 40-inch gauge and 50-inch gauge D2 tractors, has a blade length of 68 inches for the 40-inch gauge and 80-inches for the 50-inch gauge. It has a maximum lift of 25 inches and a drop of ten inches below the ground.

For additional information, write Caterpillar Tractor Company, Peoria 8, Ill., *referring to* World Oil *item* 76.

77—Portable Field Houses

This item supplements the Harnischfeger Corporation's data as shown on page 1706 of Composite Catalog.

A pre-assembled field office or camp worker's dwelling affords easy and quick erection, as it comes in finished double-walled sections. Two or three men can put it up in a day. The panel construction makes it easy to disassemble if the need arises.

Walls, floor and ceiling are completely insulated with Balsam-Wool, suiting it for year-round use. Each wall section is complete and interlocks securely with the next. Window panels have glazed sash and weatherstripping already installed. Door sections have doors already hung.

The interior of the P&H pre-assembled house provides an unobstructed area of 20 x 20 feet. If desired, this area can be divided in any manner, or with specially designed P&H wall and door partitions. Two bedrooms, living room, kitchen, bathroom, and even screened porch and car port may be added.

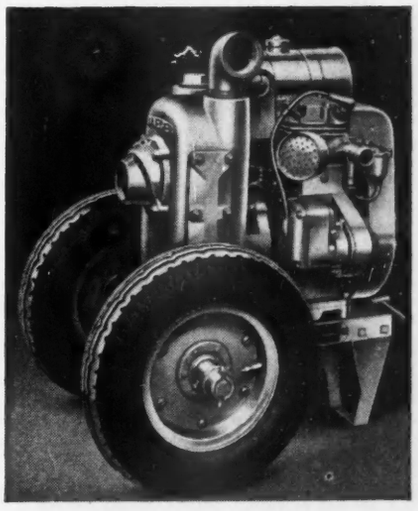
Each P&H house is supplied structurally complete with standard doors, sash, hardware trim, shutters, roofing liner, and heavy asphalt strip singles. All inside surfaces are treated with a clear, penetrating base coat and all exterior surfaces are primed white. Complete plans with step-by-step instructions and photos for erection are provided.

For additional information, write the Harnischefeger Corporation, Houses Division, Port Washington, Wis., *referring to* World Oil, *item* 77

78—High Pressure Pump

This item supplements The Jaeger Machine Company's data as shown on page 773 of Composite Catalog.

A compact, completely self-contained and easily transported pumping unit that will take water from surface supply sources and deliver it at pressures adequate for fire protection, irrigation, pressure washing and similar applications, is the Jaeger Machine Company's 2-inch portable pressure pump, Model 2PAFH. This powerful little gasoline-engine-driven unit—only slightly more than two feet square—is said to develop almost twice the pressure delivered by the usual dewatering pump of its size, yet weighs only 150 pounds.



At 10-foot suction lift, this pump has a range of volumes and pressures from 135 gallons per minute at ten pounds discharge pressure, to 30 gallons per minute at 60 pounds discharge pressure, and a maximum shutoff pressure of 70 pounds.

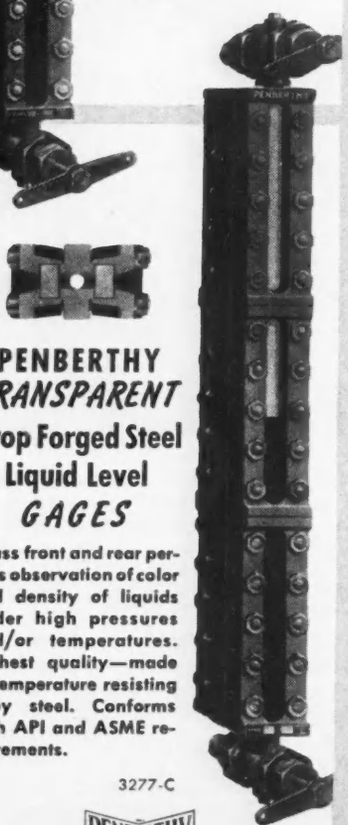
The open-bladed or trash-type impeller combines high pumping efficiency with ability to handle large solids. Jaeger patented "Lubri-Seal" seals the impeller shaft against air or water losses. The pump is fitted with a hardened and adjustable liner plate which can be easily removed and replaced after long service. The shell of the pump is an example of modern casting technique, containing no pockets or corners.

For additional information, write The Jaeger Machine Company, Columbus 16, Ohio, *referring to* World Oil *item* 78.

PENBERTHY
REFLEX and TRANSPARENT
DROP FORGED STEEL
LIQUID LEVEL
GAGES

PENBERTHY
REFLEX
Drop Forged Steel
Liquid Level Gage
Empty Space Shows White
Liquid Shows Black

Due to "Reflex" principle, liquid always shows black and empty space white. Liquid level is indicated instantly and unmistakably. Made of temperature resisting alloy steel for high pressure and temperature service. Conforms with API and ASME requirements.



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TRANSPARENT
Drop Forged Steel
Liquid Level
GAGES

Glass front and rear permits observation of color and density of liquids under high pressures and/or temperatures. Highest quality—made of temperature resisting alloy steel. Conforms with API and ASME requirements.

3277-C

PENBERTHY PRODUCTS

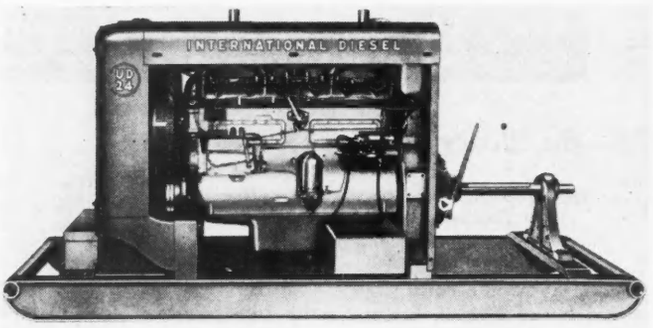
PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant—Windsor, Ontario

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

79—Diesel Engine

This item supplements International Harvester Company's data as shown on pages 2037-2040 of Composite Catalog.



A six-cylinder, 1090-cubic-inch displacement diesel engine with a 5¾ x 7-inch bore and stroke, the UD-24, is designed for heavy-duty operations in construction machinery, oil fields, cotton gins, refrigeration plants, flour mills, electric power plants, rock crushers, sawmills, and for many other applications.

The UD-24 engine develops 191 horsepower at 1375 revolutions per minute, while the UD-24 power unit, equipped with radiator, fan, clutch, and power take-off, develops 180 hp. at 1375 rpm.

Features of the engine include four-cycle design which contributes to simplicity of engine operation and maintenance; new International twin-plunger fuel injection pump, especially designed to give smooth engine operation, good governed speed regulation, superior lugging ability, and minimum fuel consumption; IH pre-combustion chamber which makes possible efficient use of low cost fuels such as No. 3 fuel oil; location of exhaust and intake manifolds on opposite sides of the engine to assure maximum power and long valve and piston life by providing free flow of cool air into the engine and free flow of exhaust gases from the engine.

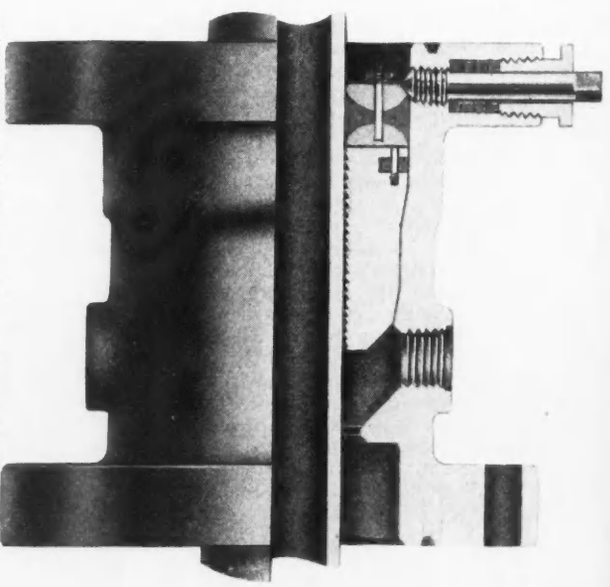
The UD-24 operates on ordinary lubricating oil without the need of oil coolers. This is achieved by the forced circulation type of cooling systems; by-pass thermostatic control; large, full-length water jackets; and the dual water manifold.

International Harvester engineers incorporated the following specifications into the UD-24: Tocco-hardened crankshaft; trouble-free, IH single-orifice injection nozzles; seven precision tri-metal 4⅛-inch-diameter main bearings; large tri-metal main and connecting-rod bearings; full-pressure lubrication through rifle-drilled passages; aluminum alloy pistons; replaceable, heat-treated, dry cylinder sleeves; large flywheel; valve-in-head construction; large oil, air, and fuel oil filters; and efficient engine sealing against dirt.

For additional information, write International Harvester Company, 180 North Michigan Avenue, Chicago, Ill., *referring to* WORLD OIL *item* 79.

80—Casing Head

This item supplements the Atlas Engineering Works' data as shown on pages 269-300 of Composite Catalog.



Double tapered slips which insure perfect alignment of the pipe load the entire length of the slip surface, with no danger of crushing the pipe on long, heavy strings being used in today's deep wells, is one of the features embodied in the new Atlas type H-S-W casing head.

A second feature is the sealing member composed of two steel backup plates with synthetic rubber between, easily placed in the casing head through blowout preventers and held in place by lock screws in the casing head flange.

For additional information, write Atlas Engineering Works, 5206 Navigation Blvd., Houston, *referring to* WORLD OIL *item* 80.

WILSON FISHING TOOLS *and Service*

Get the job done in a hurry...

The "right tools" plus the "right man" mean a substantial saving on every Fishing Job.

The Fishing Tool Division of Wilson Supply Company has been built up over many years of experience in the Gulf Coast area. Superior tools have been developed—men have been trained to handle even the most complicated job quickly and successfully.

The three Wilson Fishing Tools shown above have proven their dependability over and over again. They are available in the United States on a rental basis—for sale for Foreign use. Complete stocks and service available at Houston and Alice, Texas; Shreveport, New Iberia and Harvey, La.

Write for complete catalog on "Wilson Superior Fishing Tools"—Address: Fishing Tool Division, Wilson Supply Company, P. O. Drawer 19, Houston 12, Texas.

WILSON SUPPLY COMPANY

1412 MAURY ST., HOUSTON, TEXAS

SALES OFFICES: Tulsa, Oklahoma; Dallas, Texas.
LOS ANGELES: Western Pressure Control, 5700 Santa Fe Avenue.

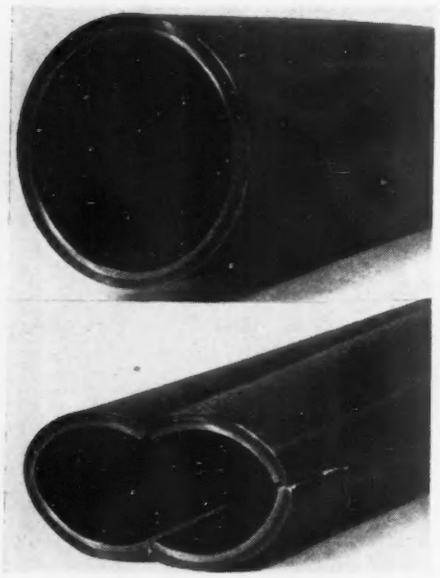
BRANCH STORES: TEXAS—Kilgore, Beaumont, Barbers Hill, Bay City, Manahans, Alice, Victoria, Corpus Christi, Columbus. LOUISIANA—Lake Charles, New Iberia, Harvey, Shreveport. ARKANSAS—Magnolia. MISSISSIPPI—Natchez.

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

81—Duax Pump Liner

This item supplements the Axelson Manufacturing Company's data as shown on pages 301-336 of Composite Catalog.



Axelson Manufacturing Company's Duax pump liner is manufactured by a process whereby specially alloyed iron, which is as hard as fine tool steel, is centrifugally cast into a seamless steel shell, using a patented method which assures an absolute bond between the two metals. As a result, the extremely hard inner surface of the liner offers great wear-resistant properties, while the tough outer steel shell prevents any possibility of the liner cracking due to brittleness. Careful "magnaflux" inspection of each liner insures uniform quality and eliminates any below-surface flaws either in the casting or in the bond between the cast iron and steel.

For additional information, write the Axelson Manufacturing Company, 616 South Boyle Avenue, Los Angeles 11, Calif., *referring to* WORLD OIL *item* 81.

82—Scraper Trap

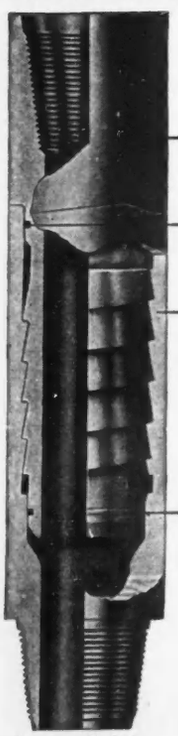
This item supplements Thornhill-Craver Company's data as shown on pages 4097-4120 of Composite Catalog.

An improved pipe line scraper trap is of hinged design which permits the operator to swing the scraper trap open or shut.

The trap employs the Unibolt design of tapered interlocking shelves between the nut member and the lug hub or blanking plug which are drawn together by simply tightening a single bolt. (On the larger sizes from six inches up, two bolts are required.) A resilient and replaceable gasket effects a leak-proof seal when the bolts are tightened. The simplified design, in contrast with conventional multi-bolt flanged traps and threaded bull plugs, allows the trap to be opened and closed quickly, without lifting heavy blind flanges off and on the line and breaking out and making up numerous bolts and nuts.

For additional information, write Thornhill-Craver Company, 1701 Lockwood Drive, Houston, *referring to* WORLD OIL *item* 82.

BOWEN SAFETY JOINT



Bowen Safety Joint Type F Patented

For

DRILLING—FISHING
FORMATION TESTING
SETTING PACKERS

O. D. and I. D. same as regular tool joints

Will not release unintentionally or back off any easier than regular tool joints.

Does not interfere with drilling, fishing or testing procedures.

Requires no special tools or attention.

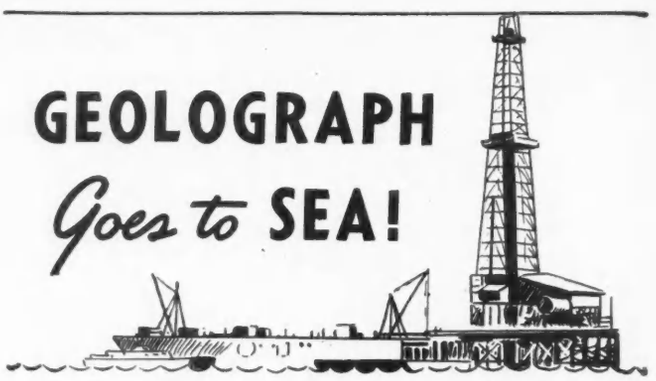
Will release only by deliberate procedure of the operator.

See your 1947-48 Composite Catalog for description and details of many other Bowen Oil Field Specialties. (Pages 687-716.)

BOWEN CO. of TEXAS, INC.

Office: 2429 Crockett St., P. O. Box 1025, HOUSTON 1, TEXAS, Phone C-9457
Odessa, Texas, Phone 789—Midland, Texas, Phone 1439

GEOLOGRAPH *Goes to* SEA!



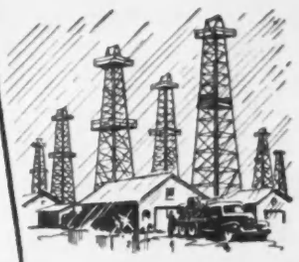
You may never drill in the ocean, but wherever you drill, *you* SAVE when *you log as you drill* with Geograph's Mechanical Well Logging Service.

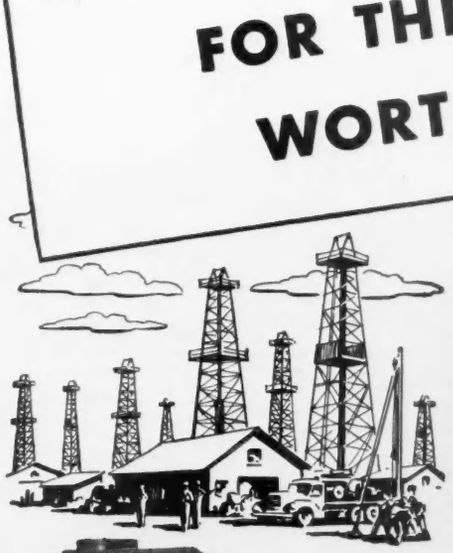
Remember, Geograph's 12-hour charts (3½ x 25½-inches) record not only the formation changes as you drill, but also the exact time of day each foot is drilled . . . and the down time.

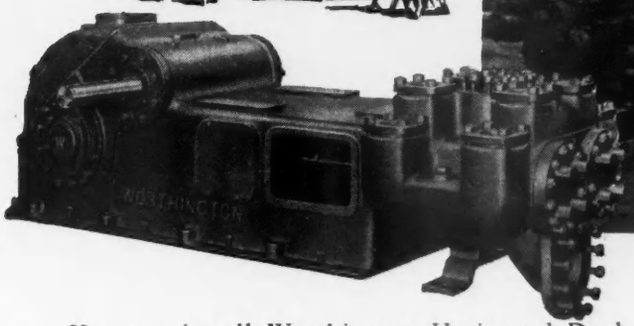
Reasonable rental rates. Write for details.

"TIME WILL TELL"
THE GEOLOGRAPH CO. INC.
P. O. Box 1291 Oklahoma City 1, Okla.

There's No "Housing Problem" FOR THESE RUGGED WORTHINGTONS







You can install Worthington Horizontal Duplex Power Pumps out in the open and forget pumping worries. Year after year, in good weather and bad, these tough, tireless performers are taking the roughest usage . . . coming back for more . . . and proving themselves unbeatable for efficient, economical oil gathering, pipeline, transfer and loading services. That's assured by thorough factory-testing before shipment.

More Sizes Than Any Other Line

Worthington Duplex Horizontal Power Pumps are made in 50 sizes, 2½" x 4" to 7½" x 12", providing the *right* pump for requirements up to 16,500 barrels a day and 1500 psi. And you'll find complete stocks at key points throughout the oil fields. For further facts proving *there's more worth in Worthington*, write to *Worthington Pump and Machinery Corporation, Reciprocating Pump Division, Harrison, New Jersey.*

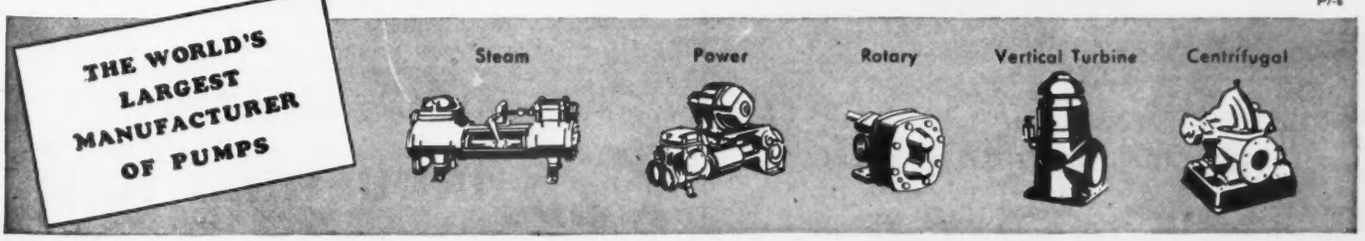
FIRST WITH *ALL* THESE VITAL FEATURES

Totally enclosed, dust-proof, oil-tight power end . . . Roller bearings . . . Herringbone gears . . . Cast steel crankshaft and connecting rods . . . Flood lubrication . . . Cast iron, one-piece, eight-pot-type liquid end . . . Each valve in separate pot for easy accessibility . . . Unbreakable, drop-forged valve pot covers . . . Removable liners . . . Deep stuffing boxes . . . Cup-type pistons.

WORTHINGTON

P7-6

THE WORLD'S LARGEST MANUFACTURER OF PUMPS



NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

83—Replaceable Blade Bit

This item supplements Herb J. Hawthorne, Inc.'s data as shown on pages 1702-1703 of Composite Catalog.

The Hawthorne replaceable blade bit decreases cost per foot of hole in shot hole and core drilling. Worn blades can be replaced right on the drill, thus reducing bit changing time to an absolute minimum.

Blades may be replaced in a matter of minutes with no special tools required. The bit cannot be assembled incorrectly and there is no movement of blades or any other part of the bit during drilling.

Different sizes of blades are interchangeable on the bit head assembly and several sizes of blades or several sets of replacement blades in the same size may be carried on the drill at all times with only one bit head assembly necessary.

For additional information, write Herb J. Hawthorne, Inc., Route 15, Box 755, Houston, *referring to* WORLD OIL *item* 83.

84—Electric Plants

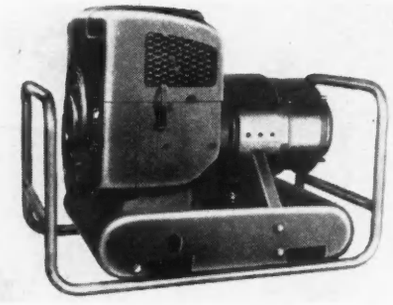
This item supplements D. W. Onan & Sons, Inc.'s data as shown on pages 3256-3257 of Composite Catalog.

A 5000-watt electric plant weighing only 272 pounds, known as the 5CK-115M, is one of a new, improved group of plants employing the new Onan "CK" air-cooled, four-cycle, two-cylinder gasoline engine as a prime mover.

These units, designed for heavy-duty service, were developed to meet the increasing needs everywhere for lightweight, high capacity independent sources of electric power. The 5CK-115R weighs only 54.2 pounds per 1000 watts, while the pounds-per-watts vary slightly for the other models in the group.

Modern, compact design and lightweight, aluminum construction make the manual starting models, either a.c. or d.c. types, easy to carry and handle on the job. Standard equipment includes a protective guard-frame and convenient four-receptacle outlet box for direct plug-in of loads.

Most models have electric push-button starting. The plant's generator, by means of a special winding, serves as the cranking motor during the starting cycle. A 12-volt automotive type battery furnishes the starting power.



Onan CK Electric Generating Plants are available in 60 or 50-cycle A.C. (2000 and 3000 watts), and D.C. (5000 watts, and 3500-watt battery charger) in stationary or portable types, with either manual or electric starting. Special accessories available include automatic controls, line transfer controls, dollies, gas-gasoline carburetion and underground fuel tanks.

For additional information, write the advertising department, D. W. Onan & Sons, Inc., Minneapolis 5, *referring to* WORLD OIL, *item* 84.

PETROLEUM PRODUCTION

Volume I. The Mechanics of Production: Oil, Condensate Natural Gas

By PARK J. JONES, Consulting Engineer, Houston, Texas

The first of a series of five volumes dealing with the application of the basic engineering principles of drilling oil wells and extracting the oil most efficiently and economically. Presented by a nationally known authority, formerly with The Texas Company, the information is highly practical, and is detailed, specific, and thoroughly documented. The treatment is as clear, concise, and simple as possible, and the explanatory matter is illustrated by extensive use of graphs.

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This is the second in a series of five volumes which will comprise the most thoroughgoing treatment of the engineering aspects of petroleum production ever presented. Contents include: The Maximum Efficient Rate of Production; Oil, Condensate and Natural Gas Reserves; Well Producing Capacity for Reservoirs; Interest Factors; The Period of Development; Uniform Rates of Production; Uniform Rates of Depletion; Economic Limits for Wells and Reservoirs; Increasing Rates of Depletion; Decreasing Rates of Depletion; The Optima for Uniform Rates of Depletion; The Optima for Variable Rates of Depletion; Exponential Functions; Natural Logarithms. **295 Pages, $4.50**

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There's a new scientific way to bridge fissures—to stop lost circulation through gravelly or porous formations. It's K-25 Industrial Fiber—developed after years of research—and proved unusually successful as a sealing agent. Made of chemically treated new wood fiber, K-25 makes lighter mud, increases viscosity. In use, it forms a dense fibrous mat for sealing walls of hole, yet has no harmful effect on water loss characteristics. Shipped in compact bales, K-25 is easy to handle—easy to add to drilling mud. Complete information about K-25 and samples of this better sealing agent are yours for the asking. Write Wood Conversion Company, Dept. 201 - 78, First National Bank Building, St. Paul 1, Minnesota.

K-25 INDUSTRIAL FIBER

Only IN W-K-M VALVES

When the valve is open, you have a round, smooth, full-bore opening entirely through the valve.

There is no gate cavity or pocket to collect sediment and prevent the valve from closing properly.

Nor are there any recesses or corners to cause swirling, churning or eddying . . . common sources of valve cutting.

Thus, the gate and the valve seats are protected against cutting or damage of any kind, whether the valve is open or closed.

The pressure is confined to the smallest possible area, the round opening through the valve. This allows the body and bonnet to be used as a grease reservoir and permits repacking the valve, or even removing the bonnet or changing the stem while the valve is under full rated pressure.

This is another of the several reasons why you may be sure that a W-K-M Valve will always effect a complete shut-off . . . will always open or close under full rated pressure.

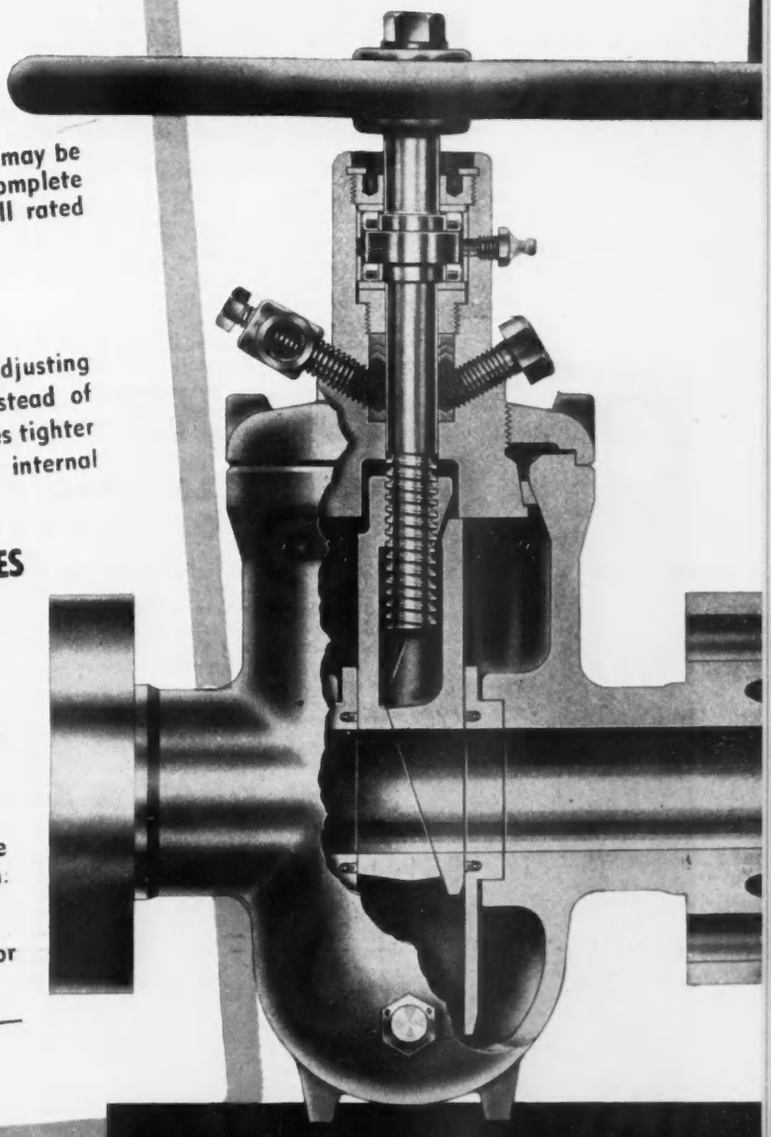
PRESSURE SEAL BONNET

Requires no flanges — no studs and nuts. Self-Adjusting to pressure and temperature changes . . . instead of tending to push bonnet off, greater pressure gives tighter seal . . . considerably less area exposed to internal pressure.

PLUS THESE OTHER PROVED FEATURES

- Lubricant contained in entire body — no special lubricant required — seal does not depend on lubricant.
- Parallel expanding gates — seal directly across both seats with no distortion whatever — positive shut off both sides.
- Oversize bronze renewable seats.
- Combination wipe and seal rings keep the gate clean . . . pressure out . . . grease in.
- Chrome plated gates.
- Double roller thrust bearings on stem for ease of operation.
- Combination plastic-chevron packing — uses no gland or gland follower.

This "THROUGH-CONDUIT" (PERFECT FLUID PASSAGE) Feature!



THIS IS THE NEW - IMPROVED W-K-M FLOW-LINE AND CHRISTMAS TREE VALVE

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OIL FIELD, PIPE LINE & INDUSTRIAL EQUIPMENT

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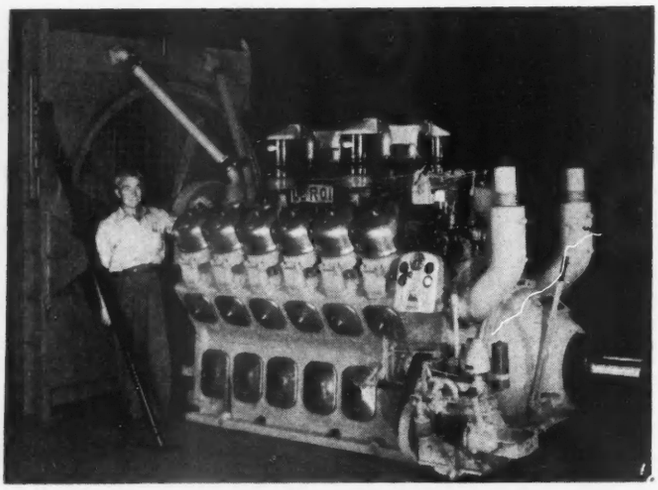
NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

85—Oil Field Engine

This item supplements the Le Roi Company's data as shown on pages 2297-2316 of Composite Catalog.



A V-12 engine with a maximum power range up to 600 horsepower has been designed especially for heavy-duty oil field service. Possible applications will be found in heavy rotary drilling rigs, mud pump drives, pipe line pumping and generator service.

This engine incorporates many new features designed for continuous service. A V-12 cylinder engine, with a 7¼ inch bore and 7-inch stroke, the displacement is 3467.7 cubic inches. Weight as illustrated is 13,500 pounds. The engine design, under development for more than four years, includes overload valves, individual cylinder heads, removable cylinder sleeves, one-piece crankcase, hydraulic valve operating mechanism, water-cooled manifolds, modern cam-ground pistons with full-floating pins and full pressure lubrication. Fuel system is adaptable to natural gas, liquid butane and gasoline.

For additional information write Le Roi Company, 1706 So. 68th Street, Milwaukee 14, *referring to* WORLD OIL *item* 85.

NIGHT and DAY
ONAN ELECTRIC PLANTS
SPEED OIL FIELD JOBS
For any kind of lighting, for operating electric tools and equipment, dependable Onan Electric Plants do the job under the severest of oil field conditions. Ruggedly built to run at full capacity continuously with a minimum of upkeep, Onan Plants have earned a reputation for low-cost reliability from coast to coast and around the world.
Lightweight one and two-cylinder air-cooled models for maximum portability. Onan two, four and six-cylinder water-cooled plants for continuous operation. Gasoline-powered from 350 to 35,000 watts. Diesel-powered from 2,500 to 35,000 watts.
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Model 5GO
5000 watts A. C.
Onan PRODUCTS
ONAN ELECTRIC PLANTS

86—All Purpose Tool Kit

This item supplements the Ingersoll Rand Company's data as shown on pages 1965-1969 of Composite Catalog.

A new Ingersoll-Rand all-purpose tool kit facilitates the repair and maintenance of machinery.

It is compact and portable and includes the new electric impact tool—with standard accessories for drilling steel, masonry or wood, reaming, wire brushing, nut-running and nut-removal, tapping, driving and removing screws, extracting broken cap screws and studs, and hole saw work.

The kit is assembled complete or with accessories as required. With standard equipment, the kit contains the impact tool with a Jacobs collet type chuck, six hex sockets of varying sizes, a Morse Taper socket, and adapter sleeve.

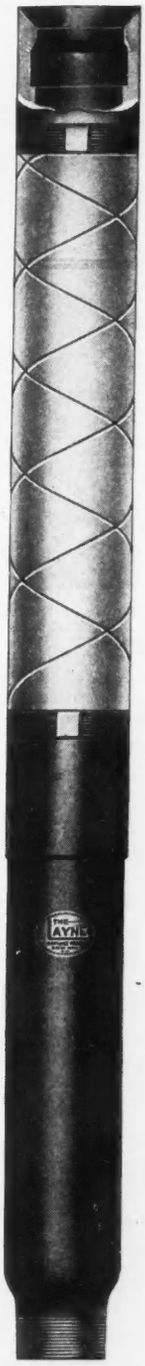
A completely outfitted kit contains all standard equipment plus twist drills, reamers, taps, carbide-tipped masonry drills, hole saws, screw and stud extractors, wood bits, wire brushes—all in sizes specified. The kit also contains screw drivers and quick change chuck, square Phillips and Reed and Prince bits, together with screw driver adapter for these bits. A universal joint and anvil extensions are available.

The impact tool is the only Universal motor driven, all-purpose tool employing the impact mechanism. It plugs into any AC-DC electric socket and runs as any conventional electric tool till the going gets tough. Then the impact mechanism automatically functions and delivers 1900 rotary impacts per minute to the job. This rotary power is essential to perform difficult jobs, without torque effect to the operator. Because of the ease and speed with which the work can be handled, it enables the operator to do any job faster and with less effort.

The impact tool is available with either 110V or 220V motors as required.

For additional information, write Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., *referring to* WORLD OIL, *item* 86.

THE LAYNE "TUBING SET" Packer

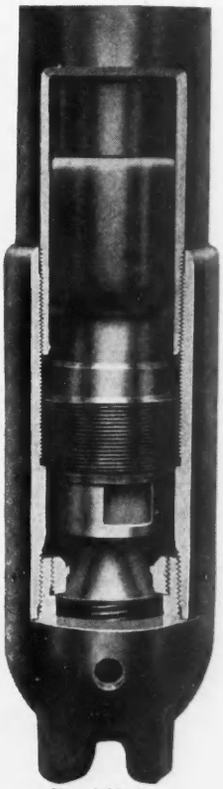


Packer Tubing-Set

You can make one trip into the hole do the job of two by using the Layne "Tubing Set" Packer. You can save time and expense of coming out with the Setting Tool and it can be used with any type tubing head or christmas tree.

The signal closing set shoe, screen liner and packer are run in the casing with the tubing connected in the set shoe and not the packer.

This packer has 36 inches of canvas and it sets with the sleeve down. With the canvas "on top," the canvas fold begins on bottom when packer is set.



Signal Closing Set Shoe

Collapsing Tool

Letting in Tool

With the Signal Closing Set Shoe there is no guessing. You know when it is securely closed.

If the pump is run slowly while the valve is being closed, circulation will stop entirely when the valve is completely closed. When the letting in tool is released from the valve, circulation will start again.

Write for Complete Information

THE LAYNE AND BOWLER COMPANY

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HOTEL WADE HAMPTON ..... Columbia

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HOTEL STEPHEN F. AUSTIN ..... Austin
HOTEL EDSON ..... Beaumont
HOTEL BROWNWOOD ..... Brownwood
HOTEL CORTEZ ..... El Paso
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MIRAMAR COURT ..... Galveston
HOTEL CAVALIER ..... Galveston
HOTEL PLAZA ..... Laredo
HOTEL LUBBOCK ..... Lubbock
HOTEL FALLS ..... Marlin
HOTEL CACTUS ..... San Angelo
HOTEL MENGER ..... San Antonio
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HOTEL MOUNTAIN LAKE ..... Mountain Lake

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GALVESTON, TEXAS

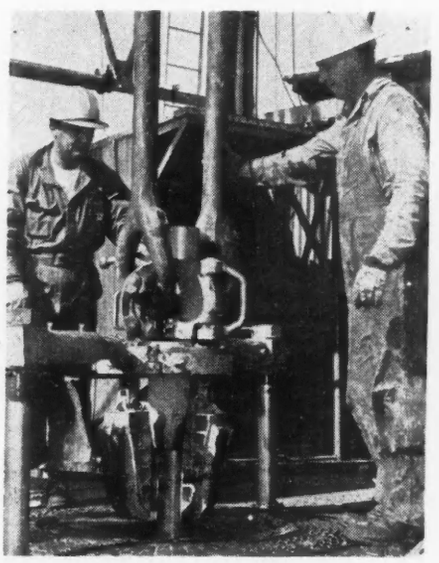
OTHER NEW AND IMPROVED Equipment

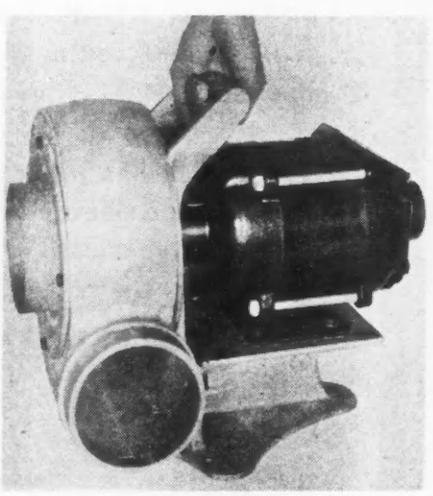
87—Safety Ventilator

Designed to save lives and improve worker efficiency by providing fresh air to men working in confined places is a light but powerful aluminum portable safety ventilator.

Called "SAF-T-AIR," the electric motor-driven ventilator has a capacity of 425 cubic feet per minute yet weighs only 50 pounds. Its compact size allows it to pass through small hatchways and hard-to-get-to places. The manufacturer states that the new ventilator will deliver more air or remove more gas through longer lengths of hose, having more bends, than any other unit of equal size or weight.

For additional information, write United Electric Motor Company, 178 Centre Street, New York 13, *referring to* WORLD OIL *item* 87.





88—Balanced Power Slips

DeCo balanced power slips feature a minimized number of working parts and speed in round trip operations. Field tests involving many thousands of feet of drill pipe and casing have been run without undue shock or strain on either.

The operating cylinders are fixed in their balanced position by means of bracket pads welded directly to the rotary, which hold slips in a centered position with it during the entire round trip operation. Many otherwise necessary working parts in power slips have been eliminated by this feature.

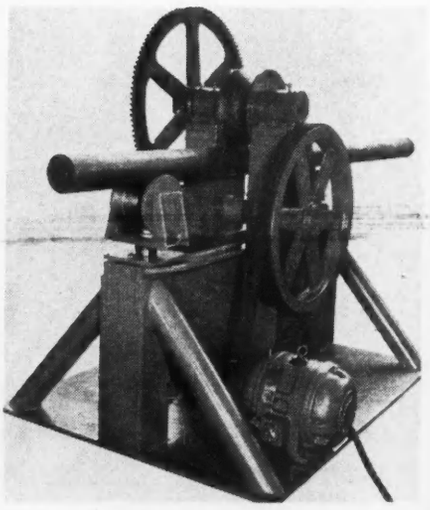
Of prime importance is the fact that the driller sets and disengages the power slips. He has full control over the slip operation, allowing the floor men safety from injury which can be sustained during the difficult and hazardous task of setting and disengaging hand slips. At the driller's position is a single foot control pedal which alternately raises and lowers the power slips. The main factor of safety is the patented automatic safety valves which prevent the operating slip pistons from going into the down position if at any time air failure should occur.

For additional information, write The DeLaney Company, 6119 East Montgomery Road, Houston, *referring to* WORLD OIL *item* 88.

89—Pipe Straightener

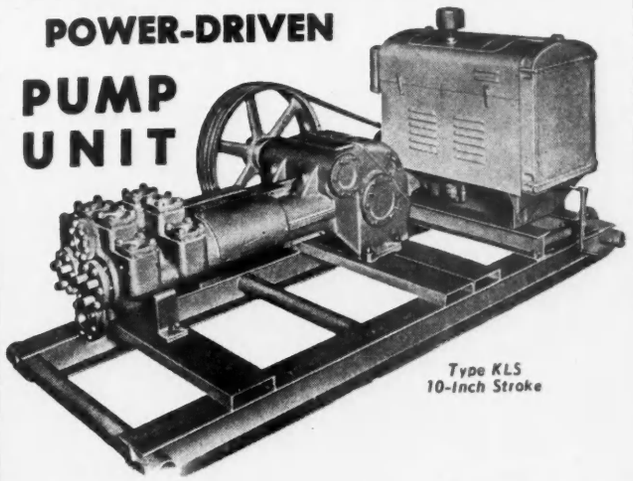
The Cox pipe straightening machine is built for the tough pipe straightening jobs in railroad shops, shipyards, oil fields and industrial manufacturing plants. Machines are available in two sizes, one with a pipe capacity up to 3½ inches and one for heavier duty with a capacity up to 5 inches.

Simply but sturdily constructed, operation of the machines does not require skilled labor.



For additional information, write Cox Manufacturing Company, Dallas, *referring to* WORLD OIL *item* 89.

LOCKETT-WORTHINGTON
POWER-DRIVEN
PUMP UNIT



Type KLS
10-Inch Stroke

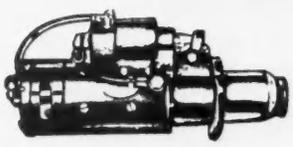
WORTHINGTON Pumps and *genuine* Worthington Repair Parts are available — through Lockett Dealers — from Warehouses maintained in the principal oil fields throughout Texas and Louisiana, backed up by a large replenishing stock at our Houston and New Orleans Warehouses. This enables Lockett Dealers to promptly supply needed equipment. Worthington Pumps are adaptable for use with Engines or Motors of any specified type or manufacture, to provide a complete pumping unit.

A. M. LOCKETT & COMPANY, LTD.
NEW ORLEANS HOUSTON DALLAS

Below Your Costs

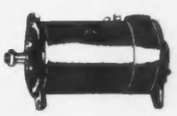
Best Buy Today
Government Surplus- New

"71"
DIESEL GM PARTS



STARTING MOTOR AND SOLENOID ASSEMBLY
- Delco Remy part No. 1108732
- 12 Volt, 900 Amps, 800 R P M
- Rotates clockwise
- Immediate delivery from stock

GENERATOR ASSEMBLY
- Delco Remy part No. 1102963
- 12 Volt variable speed
- Immediate delivery from stock



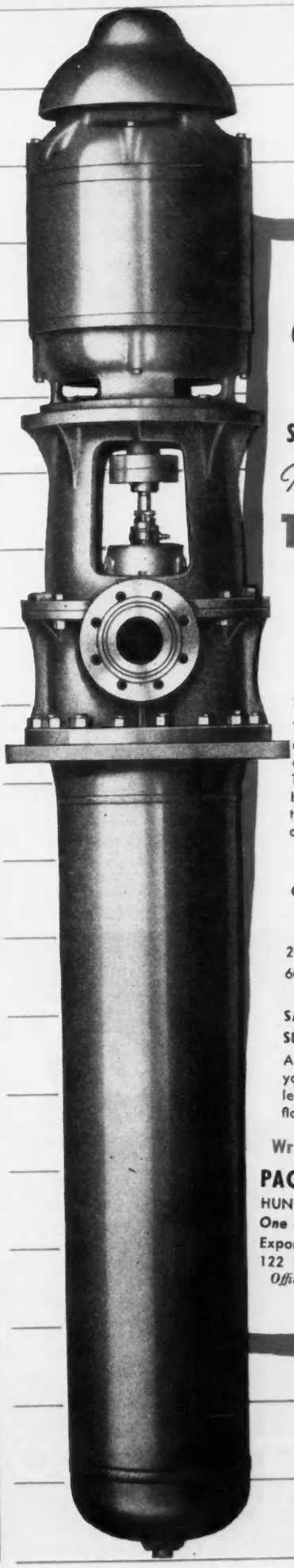
These and many more

NUMBER	DESCRIPTION
5226888	Injector Filter Element
8502957	Oil Cooler Element 12 Stack
5227325	Spray Tip and Valve Assembly
5227231	No. 80 Injector and Case
5157393	Blower Assembly—Left
5157396	Blower Assembly—Right

Write for complete parts list and low net prices.

"DIESEL PARTS SPECIALIST"

SURPLUS AUTOMOTIVE CO.
1329 S. MICHIGAN AVE. CHICAGO 5, ILLINOIS



To Reduce Construction Costs
Specify Pacific
Precision Built
Type WY
Vertical Centrifugal Pumps

SAVE BUILDING COSTS

That tight corner may be utilized without expensive alterations to the building. That new pump house may be smaller and less costly than for horizontal pumps of equal capacity.

GPM CAPACITY	FLR. SPACE IN INCHES
To - 200	18 x 18
200 to 600	24 x 24
600 to 1000	28 x 28

SAVE COST OF ELEVATING SUPPLY TANKS FOR NPSH

All a Type WY pump asks you to supply is 1 foot or less NPSH at the suction flange of the pump.

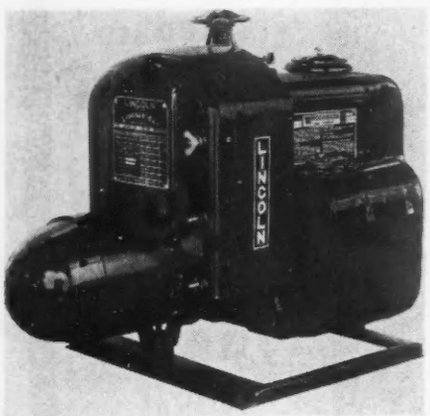
Write for Bulletin 105

PACIFIC PUMPS INC.
HUNTINGTON PARK, CALIF.
One of the Dresser Industries
Export Office Channin Bldg.
122 E. 42nd St., New York
Offices in all Principal Cities

V-1

90—Portable Welder

The Lincwelder, a portable 180-ampere welder of the gasoline engine driven type is of exceptionally compact design, roughly 2 feet wide, 2 feet high, 4 feet long, and weighing much less than the usual equipment of this type and size.



Provision is made on the output panel for three ranges of output current, continuous adjustment within these ranges being obtained by means of a simple speed control. Generator controls are mounted inside an enclosed cabinet above the generator.

The welder is powered by a Wisconsin air-cooled, two-clyinder engine. Shrouds around the engine fan and cylinders direct the cooling air. The speed of the engine determines the welding current which is controlled by adjusting the engine speed between a maximum of 2300 revolutions per minute (13 horsepower) and 1800 revolutions per minute (11 horsepower). Equipped with a 3½-gallon capacity gasoline tank, the unit will operate under normal welding conditions for approximately six hours before refueling.

Mounting rails for bolting to floor or platform permit the welder to be mounted on either shop trailer or high speed road type two-wheel trailer.

For additional information, write The Lincoln Electric Company, Cleveland 1, *referring to* WORLD OIL *item* 90.

91—Lubri-Filter

A Lubri-Filter, combining a lubricator and filter, designed for compressed air lines, protects air-driven equipment against dry-running" breakdowns and impurities in the air supply. Air is cleaned automatically by a permanent type, cleanable filter element which never requires replacement.

Atomized oil is automatically injected into the air line in proper amounts. Oil level can be seen from any angle. Model 605 Lubri-Filter is precision-built of aluminum and brass, and provides an unrestricted air flow of ¼-inch I.P.T.

For additional information, write Jarett Compressor & Equipment, Inc., Newark 4, N. J., *referring to* WORLD OIL *item* 91.

92—Protective Coating

Duratex is a protective coating which has exceptional resistance to electrolysis and corrosion.

Damage to the pipe coating compound due to shock impact caused by falling stones, etc., when the line is back-filled is one of the hazards reduced by Duratex, as it has outstanding shock impact resistance. It also has great ductility to withstand severe earth shock or movement, and because of its unusual stability earth pressures will not cause it to "slump" or "creep."

Duratex's high flash and fire point (in excess of 500° F.) adds to its safety factor during application, as does the fact that it is non-toxic.

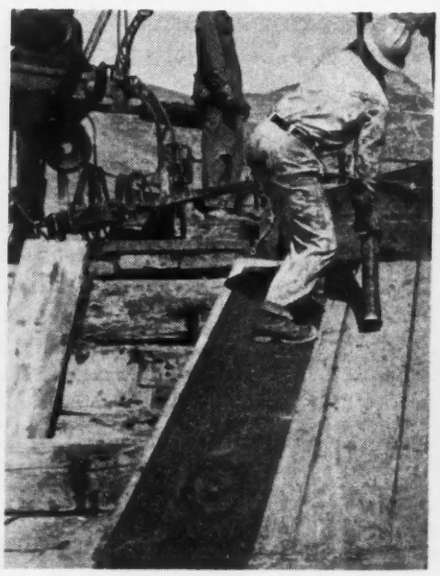
For additional information, write National Petroleum Sales, Inc., 315 West 9th Street, Los Angeles, *referring to* WORLD OIL *item* 92.

93—Non-Slip Surfacing

Slipper conditions on drill rig floors caused by oil, water, grease and chemically treated muds, are said to be eliminted by Wetordry safety walk, a non-slip, hard mineral surfacing.

A typical installation consists of 6 x 24 inch sections of Safety-Walk bonded with an adhesive to strips of one-eighth inch sheet iron of various dimensions.

For additional information, write E. D. Bullard Company, Los Angeles, *referring to* WORLD OIL *item* 93.

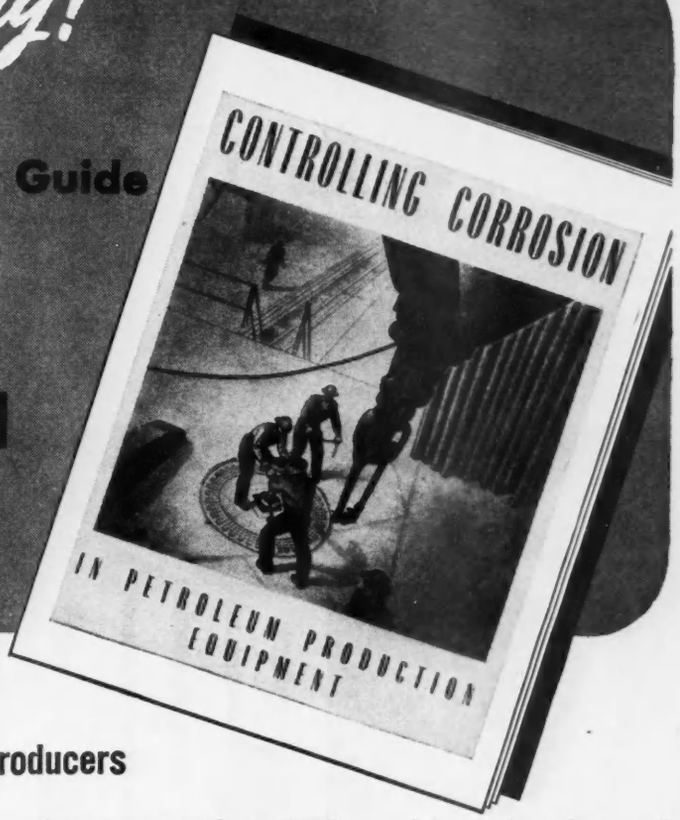


Gotkool
WATER CANS
& COOLERS
GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . . .
Gott
WATER CAN
GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. (Push-Button Faucet at slight additional cost.)
GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes with Push-Button Faucet
H. P. GOTT MFG. CO.
WINFIELD, KANSAS
KEEP PURE DRINKING WATER ALWAYS HANDY

Yours for the asking!

This Valuable NEW Guide to help you

MEET 1948's PRODUCTION PROBLEMS



Booklet just off the press contains important information for petroleum producers

Corrosion costs you money. This booklet costs you nothing.

But it can *save* you plenty!

The booklet is written especially for men who specify, make and use exploration and production equipment. It tells you—and shows you—how others have overcome premature equipment failure. Perhaps the same methods will work for you, will help you cut replacement costs and minimize production losses.

It brings you typical performance and service stories of high-Nickel alloys in a variety of corrosive uses. Its easy-to-read text is generously illustrated with photographs, diagrams of equipment, tables of physical constants and mechanical properties.

Controlling Corrosion in Petroleum Production Equipment discusses the important factors in reducing maintenance and replacement costs, there are sections dealing with exploration and drilling, pumping, gas control, and the applications of alloys that combine toughness, strength and corrosion resistance with other much-wanted characteristics.

This booklet also tells how you can get free technical advice on the selection of construction materials for severe service, and it contains a listing of valuable Technical Bulletins that are available on request.

Altogether, there's a good chance that a reading of ***Controlling Corrosion in Petroleum Production Equipment*** will reward you with at least a few sound, practical ideas. Mail us the handy coupon below, and we'll get your copy into the mail right away.

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Company.....

W. O. 7-48

Street.....

City.....*Zone*.....*State*.....

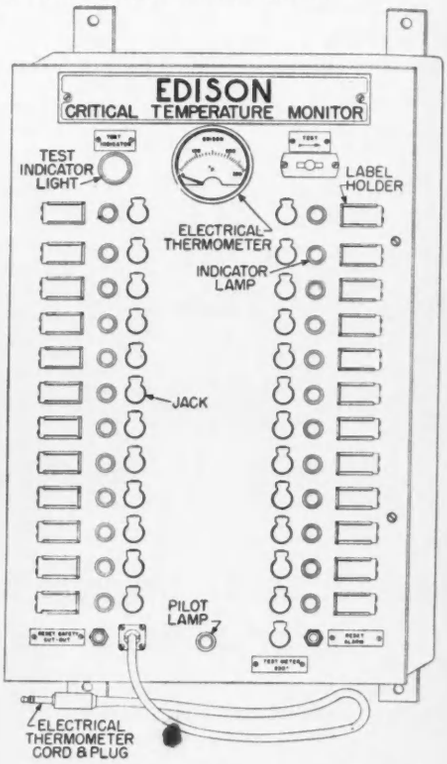
94—Monitoring System

To warn when bearings start overheating is the function of an automatic, multi-point bearing temperature monitoring system. The system is adapted both to principal equipment and auxiliaries in power generating stations, gas plants, pipe line substations, and general industrial operations.

Electrical resistance bulbs are used. Each is only .215 inch in diameter and mounted in a small hole drilled in each bearings. Only the bulb tips are temperature-sensitive and, because these tips are located in direct contact with the bearing metal very close to the actual inner bearing surfaces, existing bearing temperatures and their fluctuations are sensed rapidly.

The temperature of each bearing is checked automatically every two minutes. If, when checked, the temperature of any bearing exceeds an established maximum (which may be different for each bearing), an alarm is sounded to call an attendant. The overheated bearing is identified by an indicating lamp on the central control cabinet panel.

An attendant reads the actual temperature of any bearing by plugging into the appropriate jack an electrical thermometer which is built into the central control cabinet panel.



A modification of the system not only sounds an alarm at one established temperature, but also automatically shuts down the machine if a second, and higher, established temperature is reached. In either system, checks of the actual temperature of each bearing may be made any time at the control panel, on which facilities are also provided for the checking and testing of all circuits and alarms.

For additional information, write Instrument Division, Thomas A. Edison, Inc., 52 Lakeside Avenue, West Orange, N. J., *referring to* WORLD OIL *item* 94.

95—One-Man Hoist

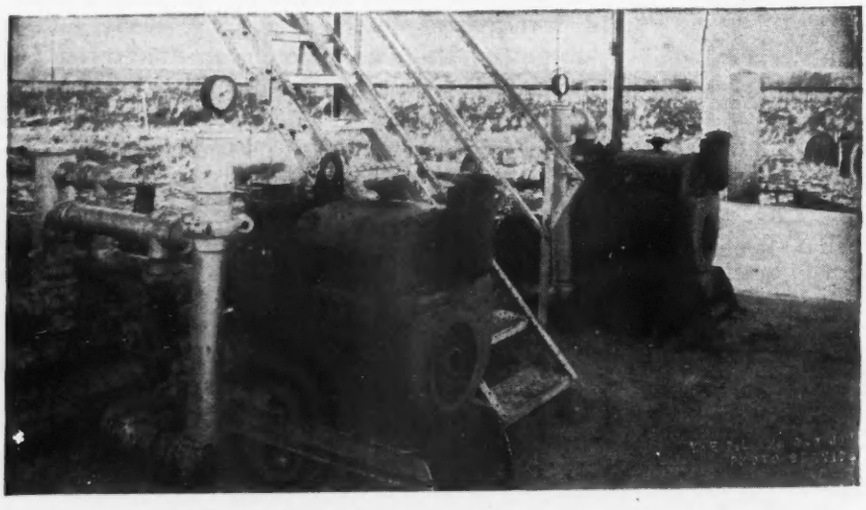
A six-pound hoist with a guaranteed capacity of 1500 pounds is designed to make the work of hoisting, pulling or wire stretching easier, less expensive, and less tiring.

Soundly engineered, the hoist is made of high tensile manganese bronze, aluminum bronze, navy bronze, Duraluminum, aircraft cable, and Cadmium Plated Steel. It can be used on any pulling job where a chain hoist or block and tackle are now used, both vertical and horizontal pulls.

For additional information, write American Gage and Manufacturing Company, 125 Bayard Street, Dayton 1, Ohio, *referring to* WORLD OIL *item* 95.

CMC PUMPS

Utility Dual Prime Model 420
4" Pump — 20 H. P.



These two Model 420 Pumps loading Lub-Oil down in Texas is typical of the many services rendered by CMC Pumps for the oil industry. Ask our engineers to help you with your specific pumping problem.

CONSTRUCTION MACHINERY CO'S.
Specializing in High Pressure centrifugals, Dual Prime centrifugals and Diaphragm pumps for the oil fields.
WATERLOO, IOWA
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TELEPHONE HADLEY 3988

Announcing

THE NEW FWD MODEL·ZU

Four-Wheel-Drive Truck

Years Ahead in Heavy Duty Truck Features

Rated at 33,000 lbs. G.V.W., the new FWD Model ZU offers the most advanced features available in a modern heavy duty four-wheel-drive truck:

*ENGINE: Full 188 H.P., overhead valve, wet-sleeve type, counterbalanced crankshaft.

*TRANSMISSION: 5 speed with helical gears in constant mesh *at all speeds;* extremely wide range from direct to 9.95:1 in low.

*SILENT CHAIN TRANSFER: FWD proven type; enclosed and operating in oil bath.

*NEW CENTER DIFFERENTIAL LOCK: Vacuum controlled with tell-tale warning light; touch-button locking and unlocking.

*NEW AXLES: Front and rear, of FWD's proven single reduction design. Large spiral bevel ring gears and pinions; axle design tested in more than three years severe oil field service.

*STURDY 8-SPOKE WHEELS: with locked rims to take the torque.

*HIGH TORQUE HYDRAULIC BRAKES: Hydrovac-operated with full floating shoes, double wheel cylinders, ample braking power for truck and load under all conditions.

*GIRDER TYPE FRAME: designed for rugged strength plus ease of equipment mounting. Center pivoting radiator mounting to eliminate core stresses.

*ALL STEEL TURRET TYPE SAFETY CAB: Designed for operator comfort. 30% greater visibility. Centrally grouped controls and instruments. Adjustable seats — large glove compartment. Air conditioning optional.

*NEW CROWN-TYPE FENDERS WITH INTEGRATED SKIRTING: Designed for convenient, easy access to engine. Skirting removable in one piece for easy installation of front mounted equipment. Three piece hood with readily removable, hinged side panels.

FWD

America's Foremost Heavy Duty Truck

See your nearest FWD distributor or write for complete information.

THE FOUR WHEEL DRIVE AUTO COMPANY
CLINTONVILLE, WISCONSIN
Canadian Factory: KITCHENER, ONT.

96—Jet Perforating

How to perforate casing for deeper penetration and increased oil flow with Welex jet perforating is the subject of a four-page bulletin.

The jet method of penetration is claimed to give 300 percent deeper penetration, with no damage to casing or well and greater safety for personnel. Excerpts from AIME and API papers describing the operation of jet perforations are included in the bulletin, along with color photos of the device, a price schedule, and other information.

For additional information, write Welex Jet Services, 3909 Hemphill Street, Fort Worth, Texas, *referring to* WORLD OIL *item* 96.

97—Corrugated Piling

Folder No. F-110 gives advantages, physical characteristics, suggested applications, etc., of high-strength, box-type corrugated piling, which is especially suited for use where heavy piling is not necessary.

For additional information, write L. B. Foster Company, Box 1647, Pittsburgh 30, *referring to* WORLD OIL *item* 97.

98—Hyster Booklet

How Hyster equipment adds to the versatility of the Caterpillar track-type tractor is presented in a 36-page, generously-illustrated booklet. Actual field photographs show many uses of the tractor and Hyster winches. Specifications and illustrations of Hyster's line of towing winches are included as well as other Hyster equipment designed specifically for Caterpillar track-type tractors.

For additional information, write Hyster Company, Peoria, Ill., *referring to* WORLD OIL *item* 98.

99—Welding Fittings

The Tube-Turn Catalog and Engineering Data Book No. 111, which has come to be regarded as the "Bible" on the subject of welding fittings and flanges for industrial piping, now has a 20-page supplement.

The supplement is devoted to specifications that cover new items in the continually expanding line of Tube-Turn fittings. It is six by nine inches and slips easily into the pocket provided for this purpose on the inside back cover of No. 111.

For additional information, write Tube Turns, Inc., 224 East Broadway, Louisville 1, Ky., *referring to* WORLD OIL *item* 99.

100—Oil Tank Coating

Details of field and laboratory tests conducted during the past two years on "Coro-Gard," a recently-announced anti-corrosion coating for oil tank interiors, are given in a brochure.

Citing test applications to tanks in sour crude fields since 1945, the booklet emphasizes that the coating has withstood "the corrosive effects of sour crude, salt water, and acidic salt solutions, as well as the harsh treatment of steam cleaning."

For additional information, write Minnesota Mining and Manufacturing Company, St. Paul, Minn., *referring to* WORLD OIL *item* 100.

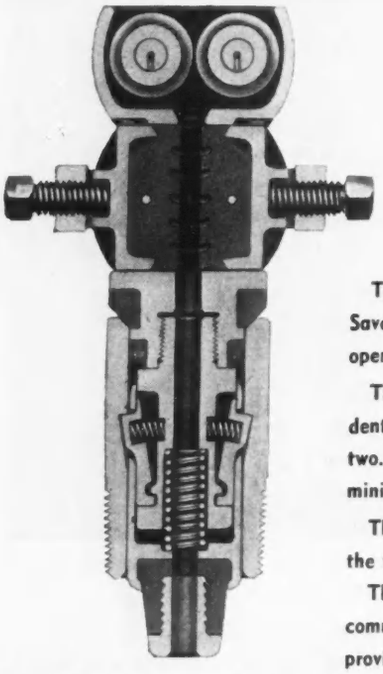
101—Working Pressures

An enlarged edition of the booklet, "Allowable Working Pressures," gives allowable working pressures for Tube-Turn welding fittings in five classes of piping. The tables are based upon the ASME Boiler Construction Code, 1946 edition, and the American Standard Code for Pressure Piping, ASA B31.1, 1942, as revised by supplement No. 2, ASA B31.1b, 1947.

The booklet's subjects deal with piping; gas and air piping (Division 1, within plant or city limits; and Division 2, cross country piping systems); oil piping within refinery limits; oil piping outside refinery limits; and district heating piping. Also covered are plant process piping and hydraulic machinery piping, which are not included in the code for Pressure Piping.

For additional information, write Tube Turns, Inc., 224 East Broadway, Louisville 1, Ky., *referring to* WORLD OIL *item* 101.

For Swabbing Operations



Be Sure IT'S A KING Be Safe

TYPE 3AR AUTOMATIC RELEASE WIRE LINE STRIPPER

Type 3AR King Wire Line Stripper (often called "Oil Saver") is the ideal tool to use in connection with swabbing operations.

The positive latch and sure release insure against accidents and eliminate the possibility of jerking a wire line in two. The non-sparking materials used in its construction, minimize the fire hazard.

The packing is inserted from the sides of the tool and the tool can be repacked while the line is in the hole.

The roller line guides center the line and outlast the more commonly used bushing many times. Grease nipples are provided to lubricate the guide rollers. Convenient hand holds contribute to easy handling of the tool. *This tool is constantly coming into greater use.* A trial is convincing.

FOR WIRE LINE CORING
the 4AR KING WIRE LINE STRIPPER is widely used

The Type 4AR Stripper is similar to the Type 3AR, except it is a little larger. It is commonly used in connection with the Type 4C King Circulating Head. It can be, and sometimes is used with other makes of circulating heads.

All prices F.O.B. Houston, Texas, and subject to change without notice.

Sold through your supply store
Export: R. S. STOKVIS & SONS, Inc.
17 Battery Place, New York 4, N. Y.

See 1948 Composite Catalog (Pages 2129 to 2140) for detailed description of other King Tools.

KING OIL TOOLS

210 TERMINAL STREET PHONE W. 6-8013
HOUSTON 10, TEXAS

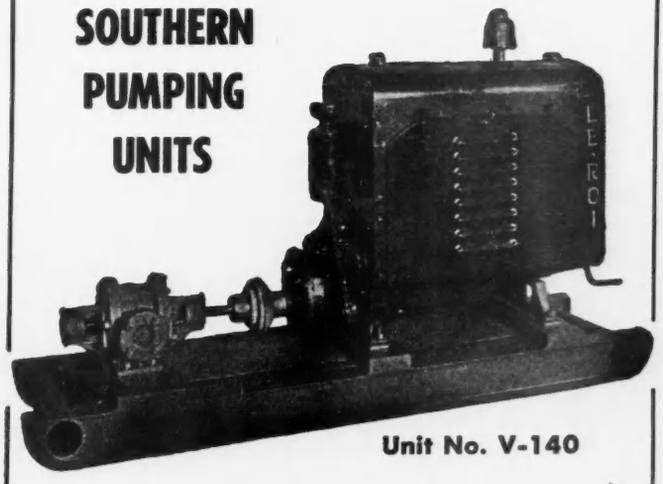
The
Igloo WATER COOLER
"the truly Convertible Cooler"

This cooler is corrugated for greater strength and durability being of all welded construction. It is fully insulated with granulated cork to keep water colder longer. Added features include, conversion from spigot to non-spigot type, no solder joints to break out and a reinforced innerbottom.

Igloo Water Coolers and Spigots Are Available at All Supply Stores

The IGLOO MANUFACTURING CO.
3809 McKinney Avenue Houston 3, Texas

SOUTHERN PUMPING UNITS



Unit No. V-140

Le Roi Power Unit — Viking Pump Capacity 140 barrels per hour.

Complete units and replacements in Houston and Kilgore stocks.

SOUTHERN ENGINE & PUMP COMPANY

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Save
PIPE WRENCH TROUBLE AND EXPENSE

RIDGID pipe wrench housings are guaranteed forever against break or warp

● That guarantee means you can forget wrench housing bothers and repair costs when you buy RIDGIDs. Other RIDGID features make sense too—free-spinning adjusting nut; convenient pipe scale on hookjaw; instant-action non-slip, non-lock jaws and powerful comfort-grip I-beam handle. No wonder it's a favorite with millions of men all over the world who know fine tools. Sizes from 6" to 60" — try them and buy them at your Supply House.

RIDGID
Strap Wrench won't mar polished pipe or tubing.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

Times may change, but the problems of today parallel those of years gone past. Adequate financing has always been of foremost importance in the Oil Industry. If you need additional working funds to successfully complete a job look to

1st of Tulsa

THE FIRST NATIONAL BANK AND TRUST COMPANY OF TULSA

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Corrosion Fatigue

Sir:

I have read with great interest B. B. Morton's article on "Corrosion Fatigue of Oil Well Equipment," page 156, etc., of the April issue of WORLD OIL. With most of his statements and conclusions I am in complete accord, with some I am not so sure, and with a few I disagree. I thought you might be interested in a few comments which occurred to me while studying the article.

For one thing, I agree that the wording to warn against keeping drill pipe in compression is rather unfortunate. I try to convey the idea he suggests, that of keeping the pipe in tension, *so as to avoid bending stresses.*

At the top of the third column on page 158, Mr. Morton is a little dismayed that there is "no crack starting (on the outside of drill pipe) during the time that is required for the mud to round out the base of the pit." I believe it is not mud which "rounds out the cracks or pits" but abrasion against the sides of the hole. Even close to, and right under, tool joints (lifting shoulders), we in the field often notice considerable polishing of the pipe surface, and it has always been my opinion that abrasion continually wipes off the infinitesimal starting points of corrosion pits.

As pretty good proof of this we occasionally encounter bent lengths of drill pipe, which evidently were operating near the bottom of a string and on the outside of which there are deep corrosion fatigue pits and cracks, *all on the concave side of the bow.* Also, we sometimes find good evidence of external corrosion fatigue near tool joints where, by chance, no ledges or other irregularities in the hole were able to abrade off the drill pipe surface.

By a similar line of reasoning, it is my opinion that only a very small percentage of the oxygen present in the mud, as it enters the pipe, is consumed on its way down. Otherwise we would not find the evidence of severe external corrosion on the outside surfaces of drill pipe, as in the case illustrated in Mr. Morton's Figure 4, and as mentioned in my preceding paragraph. However, I believe that the suggested study of "oxygen balance" in a mud system would be very interesting. Unfortunately, the shale shakers and settling pits of rotary drilling rigs make a very beautiful aeration system.

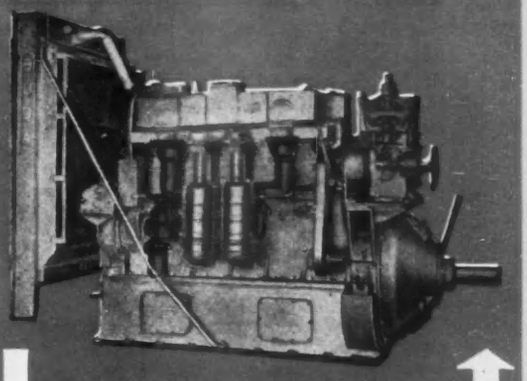
Near the top of the first column on page 162 the author states that "considerable corrosion must occur in a given area to produce an effective stress intensifying pit." In general this is true, but I recall one example of an extremely fine grained steel, with low nickel-copper content, in which pitting was so fine that it was not detected with the naked eye until specimens had been cleaned in a laboratory. And yet this drill string had developed a half dozen true corrosion fatigue failures before drilling two-thirds of its first well and was discarded (as junk) before completing that well.

I, and my co-workers, agree most

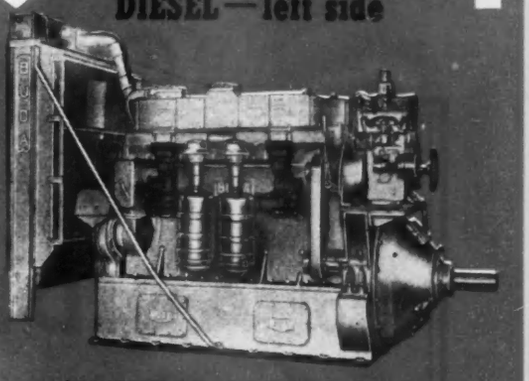
SAVE 42% WITH BUDA

Convertible Drilling power!

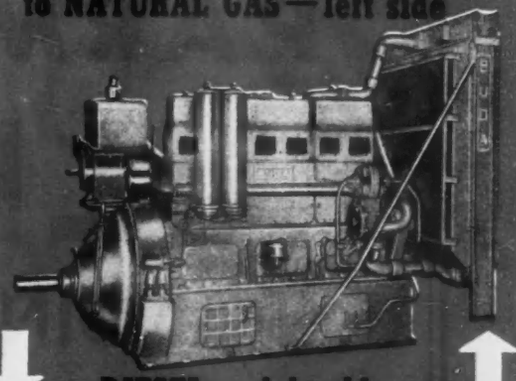
Why go to the extra expense of *two* separate engines for Diesel and natural gas fuel, when *one* Buda 1879 convertible will give you efficient operation on *either* fuel—at an approximate *saving of 42% in first cost!* With the big 1879 Diesel, parts for conversion to natural gas add only 5% to your original investment. You simply remove fuel injection system and energy cell assemblies . . . install carburetor and spark ignition system . . . and you're ready to go with natural gas or butane. To convert from natural gas to Diesel, you just reverse the procedure. Simple and easy to do . . . lets you use most advantageous fuel at all times . . . saves costly changes in rigs and mountings. See your Buda oil field distributor for complete details, or write: The Buda Company, Harvey, Illinois.



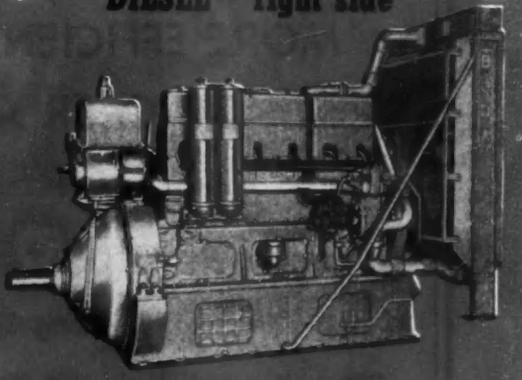
DIESEL—left side



to NATURAL GAS—left side



DIESEL—right side



to NATURAL GAS—right side

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heartily with the suggestion of coating drill pipe with an "impervious, resistant lining." With what modesty I can assume I would point out that our company has led the field in experimenting with phenol-formaldehyde thermal setting plastics, for the past several years, and with very satisfactory results. As far as I know we are still the only pipe mill regularly coating drill pipe today in spite of the very favorable findings of Battelle.

Right now I and my field men are closely watching two strings of our drill pipe, both being used by the same contractor, to drill only the "salt string hole" (through the Permian beds in West Texas), one coated and one unprocessed. As of April 8th the uncoated string had experienced seven corrosion fatigue failures in drilling 20,875 feet of hole. As of the same date the coated string had drilled 46,808 feet of hole with three failures, all being notch fatigue (or notch-corrosion fatigue) failures in external scars or slip marks. It had drilled 40,386 feet up to the time of the first failure.

I agree with Mr. Morton that internally coating with nickel might be very excellent, if not too expensive, but I do not believe it need be flashed with chromium. Mud velocities are too low, inside drill pipe, to have any appreciable abrading effect, except possibly on organic coatings.

I have already indicated that, in my opinion, you cannot "move the corrosion down and toward the outside due to the fact that oxygen is consumed." Witness, above, the comparison between the coated and uncoated West Texas drill strings. Without ever having done any calculating as to quantities of oxygen involved, I have always had the feeling that there is too great a quantity of it to be used up in passing down and up even a very long string of drill pipe. I could be wrong, however.

I, too, understand that a 9 percent nickel alloy steel has been showing interesting results in resistance to distillate corrosion and I intend following the various tubing strings which several operators have on order. It would be interesting to try out this alloy in drill pipe, but, again, I would fear the cost, as compared with plastic coated pipe.

In conclusion I want to thank the author for his very kind remarks made about Grant's and my paper on Drill Pipe and Tool Joint troubles. Coming, as it does, from a stranger, I take it as the very highest form of compliment.

H. G. TEXTER,
Chief Field Engineer,
Spang-Chalfant Division,
The National Supply Company,
Tulsa 3, Okla.

Collecting Cooling Water

Sir:

On page 212 of your March 1948 edition of WORLD OIL, we noticed a small article on how to collect cooling water.

This idea as presented certainly has merits but we would like to point out that the rain water collected by this system is generally acid in nature and can be highly corrosive to the cooling system. This is particularly true when used with engine radiators and if used for this application, we think it should be pointed out that the water should be treated before applying to the system to prevent this acid corrosion. There are many chemical products on the market for this purpose and the treatment is simple.

The water for this type service should have a pH of not less than 8.0 and preferably 8.5.

If this is overlooked, expensive repairs of radiator cores may show up even though the water is considered to be very pure.

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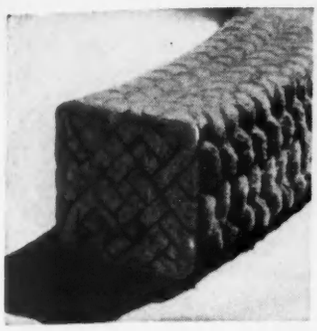
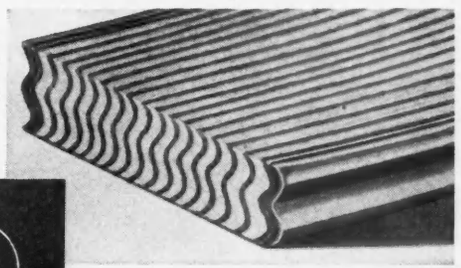


Upper left: GARLOCK Lattice-Braid Packing

Upper right: GARLOCK Chevron* Packing



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Lower: GARLOCK Guardian* Gasket (Cross section view)

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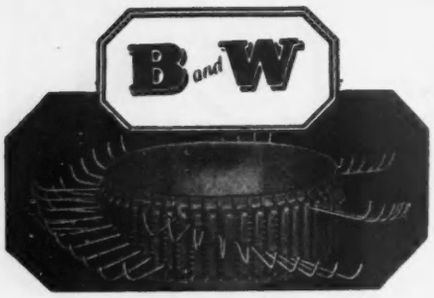

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Associations

PIONEERS HONORED—Near a replica of Pennsylvania's historic Drake well at the International Petroleum Exposition grounds at Tulsa, the American oil industry honored its pioneers. Only three of the eight men honored were able to attend. Shown during the ceremonies are some of the recipients of the IPE "old timers" awards. Left to right are W. L. Connelly, Sinclair Prairie Oil Company, chairman of the Pioneer in Petroleum Committee; Mrs. Frank Wood, who received the "Pioneer of Pioneers" award for her father, Frank Haskell, of Sharon, Conn.; Dana H. Kelsey, Sinclair Prairie Oil Company, Tulsa, pioneer in land, lease and legal activities; B. E. Hull, The Texas Company, Houston, pioneer in pipe lines; Herbert Straight, Cities Service Oil Company, Bartlesville, pioneer in production. Others who were honored include Frank Phillips, chairman of the board of Phillips Petroleum Company, Bartlesville, who was named "Grand Old Man of Oklahoma;" Ralph W. Gallagher, president of Standard Oil Company of New Jersey, pioneer in natural gas; George W. Bovaird, Bradford, Penn., pioneer in oil field equipment; Charles L. Suhr, Pennzoil Oil Company, Oil City, Penn., pioneer in refining.

Stewart Elected Chairman Of Corrosion Research Group

W. H. Stewart, Sun Oil Company, Beaumont, Texas, has been elected chairman of the Corrosion Research Project Committee of the Natural Gasoline Association of America. He succeeds T. S. Bacon, Lone Star Producing Company, Dallas.

F. A. Prange, Phillips Petroleum Company, Bartlesville, was elected vice chairman of the committee and succeeds M. E. Holmberg of the same company.

The Steering Committee, of which Stewart is also chairman, is composed of F. A. Prange, vice chairman; T. S. Bacon, Walter Rogers, Gulf Oil Corporation, Houston; P. P. Spafford, Stanolind Oil & Gas Company, Houston; and T. S. Zajac, Shell Oil Company, Inc., Houston.

At the recent meeting, plans were made for continuing the work of the Corrosion Research Project Committee for another year with a view to extending the studies of the fundamentals of corrosion for a period of four years. Three research programs at The University of Texas were approved. These will be under the respective direction of Dr. Norman Hackerman, Department of Chemistry, Dr. H. L. Lochte, Department of Chemistry, and D. A. Shock, Off-Campus Research Center. C. K. Eilerts will continue his studies at the U. S. Bureau of Mines in Bartlesville.

API Rocky Mountain District Elects J. C. Johnson Chairman

J. C. Johnson, Continental Oil Company, Denver, has been elected chairman of the Rocky Mountain district, Production division, American Petroleum Institute, succeeding H. A. Stewart, The Texas Company. Other officers elected at the May 27-28 meetings are James D. Anderson, The Ohio Oil Company, Casper, Wyo., chairman of the advisory committee; Zack Brinkerhodd, Casper, vice chairman for Wyoming; W. M. Saxon, The Pure Oil Company, Billings, Mont., vice chairman for Montana; and A. F. Barrett, General Petroleum Corporation, Casper, secretary-treasurer.

Frank O. Prior, director of the American Petroleum Institute and vice president of Standard Oil Company (Indiana), gave a general review of the problem of national supply and demand and discussed the part production in the Rocky Mountain area will play, and has played, in the solution of the problem. He also reviewed public and political considerations bearing on production, supply, and demand.

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Other speakers, and abstracts of their talks, are presented below:

Developments and Trends in Oil-Field Producing Practices

By JAKE L. HAMON, Cox and Hamon, Dallas, API vice president for production.

Some of the more important developments in modern production practices which contribute to more effective operations and greater ultimate recovery of oil were considered. Items discussed included proper utilization of reservoir energy; unitization; secondary-recovery methods; pressure maintenance; fundamental research; cycling; and standardization of oil field equipment.

Production Problems—Adon Block in Powder River Basin

By H. A. TRUE, JR., Wyoming District Superintendent for The Texas Company.

A well drilled last year by The Texas Company in the central part of the Powder River Basin aroused considerable regional interest, as it was the first well to encounter commercial production in the heart of this tremendous basin. This well was the Texas Adon Unit No. 1, Sect. 2, T-52-N, R-72-W, in Campbell County, Wyo. Production was obtained from the upper 15 feet of a sand of the Minnelusa group of Pennsylvanian age, encountered from 8997 to 9022 feet. After the well had been drilled into the Madison and had reached a total depth of 9945 feet, casing was run through the Minnelusa. Considerable trouble was experienced by the operator in obtaining production from the saturated zone. Squeeze cementing, repeated gun perforation, "marble" shots, and an SNG shot were employed before the first oil was recovered from the well. Characteristics of the oil, gas, and reservoir sand were also discussed.

Secondary Recovery in the Rocky Mountains

By C. M. NICKERSON, District Engineer, U. S. Geological Survey, Midwest, Wyo.

Secondary recovery of oil in the Rocky Mountain region has been limited to gas injection. The two or three water-injection projects under way are experimental. Colorado has two gas-injection projects, viz., at Wilson Creek field and at North McCallum pool. In Montana gas has been injected into at least four zones in the Cut Bank oil field, and into one zone in the McGuinness pool. In Wyoming there are 13 gas-injection projects (recycling or pressure-maintenance) in one or more sands in the Cole Creek, Elk Basin, Grass Creek, LaBarge, Lance Creek, and Salt Creek oil fields. Experimental water floods are under way in the Cole Creek and Salt Creek fields of Wyoming, and these have yielded encouraging results. There are no known water floods in Colorado or Montana. Salt Creek is the outstanding example of a successful gas-injection secondary-recovery project; it has been under way since 1926. Gas has been injected in the Lance Creek oil field since 1938 with substantial results. More such projects may be expected in the future. Detailed reservoir data on practically all secondary-recovery projects in the Rocky Mountain region will be given in tabular form in the forthcoming secondary-recovery publication of the American Petroleum Institute.

What Engineers Expect of Management

By FRED M. CLEMENT, region engineer for Continental Oil Company, Denver.

This paper presented answers to the author's recent letters to leading Rocky Mountain engineers, in which letter he asked for suggestions on the subject suggested by the title.

The Development of Mush Creek

By J. A. ZISER, Petroleum Engineer for Phillips Petroleum Company, Denver.

The history, geology, and the drilling and completion practices, as well as the production data and the estimated oil reserves, of the Mush Creek oil field, which is located in Township 44 North, Range 63 West, in Weston County, Wyoming, were discussed.

Employer-Employe Relations

By JOHN R. McNULTY, Division Director of Personnel for The Ohio Oil Company, Casper, Wyo.

A consideration of the nature of employer-employe relations, together with a discussion of the interests of each, was given. The author suggested methods of improving these relations, especially by careful selection of employes and good orientation and induction, with special emphasis on employe recognition through the medium of adequate supervisory and employe training.

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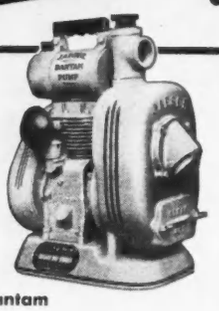

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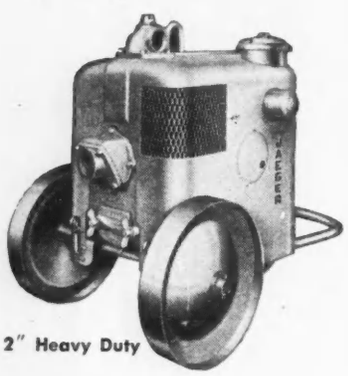
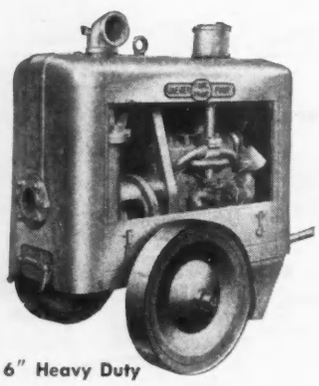


2" Heavy Duty



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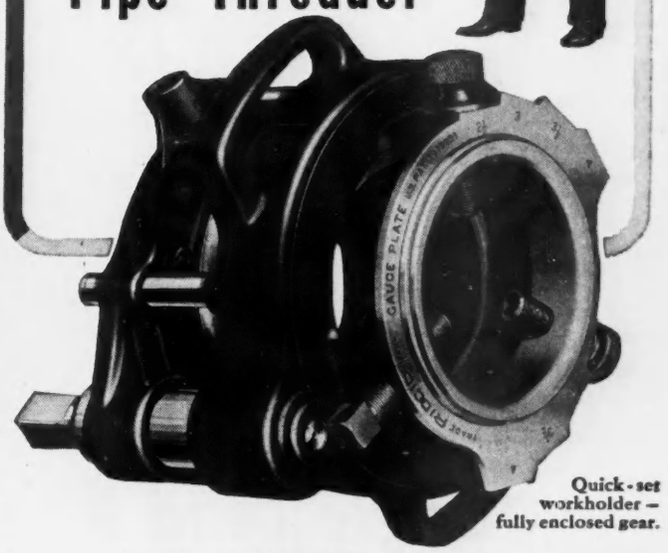

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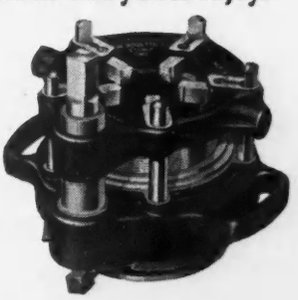

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Quick-setting Workholder. Mistake-proof — sets to size *before* you put it on pipe, no bushings. . . .

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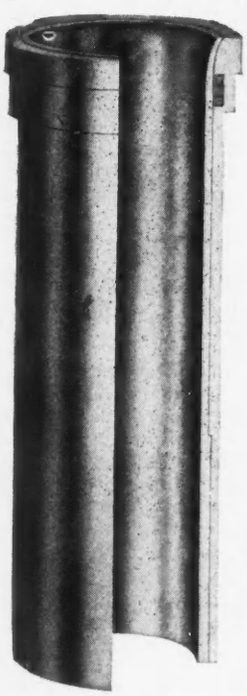

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Public Relations Chief Named by Western Group

Jerry Luboviski, former city editor of the Los Angeles *Daily News* and the San Diego *Daily Journal,* has been appointed public relations representative of the Western Oil and Gas Association with headquarters in Los Angeles. The association represents approximately 90 percent of the oil industry on the west coast.

For two years prior to taking over the city desk on the *Journal* and then the *Daily News,* Luboviski was assistant director of public relations for North American Aviation, Inc. He also was with the United Press, working in the Los Angeles bureau, and worked for the Los Angeles Examiner.

Oklahoma City Geologists Elect Wheeler President

Dr. Robert R. Wheeler, consulting geologist, was elected president of the Oklahoma City Geological Society. Other officers include L. R. Wilson, The Carter Oil Company, vice president and chairman of the program committee; Elwin Owens, Phillips Petroleum Company, treasurer, and John Janovy, Tide Water Associated Oil Companies, treasurer.

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West-Central Texas Oil & Gas Association Elects V. C. Perini

The West-Central Texas Oil & Gas Association elected the following officers: V. C. Perini, Jr., president; French M. Robertson, vice president; and Lester Clarke, vice president.

Directors are J. P. Byram, C. M. Caldwell, M. G. Cheney, L. H. Choate, Frank Conselman, Edgar Davis, Dave Dean, F. A. Dunigan, Norman Fitzgerald, Art Frazier, E. M. Funkhouser, Ed S. Graham Jr., Tom F. Grisham, Luther Hedrick, C. W. Hoffman, L. F. Hooker, J. C. Hunter Jr., W. K. Hyer, Phil Kendrick, Chas. Kleiner, E. R. Marchman, J. E. Mathews, Malcolm Meek, W. J. Murray Sr., Harold Neely, L. R. Pearson, H. L. Pinkerton, P. W. Pitzer, R. L. Ponsler, W. R. Ransone, W. J. Rhodes, George Ritchie, Jack B. Robert, S. B. Roberts, Charles Roeser, Harley Sadler, J. D. Sandefer, Carl Springer, O. B. Stephens, W. E. Tyler, E. A. Ungren, R. M. Wagstaff, L. A. Warren, J. M. Weaver, C. K. West, J. F. West, Horace White, J. E. Whiteside, G. R. Whitney, and Ernest L. Wilson.

Dallas Geophysical Society Elects Newton President

W. W. Newton, Geotechnical Corporation, has been elected president of the Dallas Geophysical Society. K. E. Burg, Geophysical Service, Inc., is first vice president; D. Ray Dobyns, Magnolia Petroleum Company, second vice president; and W. G. Smiley, Sun Oil Company, secretary-treasurer.

A. E. McKay, The Atlantic Refining Company, past president of the society, and Paul E. Nash, Magnolia Petroleum Company, were elected district representatives of the Society of Exploration Geophysicists.

Paul Torrey Tells Committee Of Secondary Recovery Rights

Authority to permit or regulate secondard recovery operations already exists in most oil-producing states, although in some instances it is probable that clarification or amplification of laws might be desirable, Paul D. Torrey, chairman of the Interstate Oil Compact Commission's Secondary Recovery Advisory committee, reported to the Compact's executive Committee.

Reviewing laws relating to secondary recovery and cooperative pooling or unitization agreements as they may affect such operations, Torrey pointed out that many existing secondary recovery and pressure maintenance projects would not be successful in the absence of some form of pooling or unitization of property interests.

The Compact is urging statutory review by each state to insure that there are no legal obstacles to inauguration of most scientifically advanced recovery methods. Several states have passed specific laws relating to secondary recovery operations, Torrey said. In others, authority to regulate such operations exists in the general conservation statute.

ASSOCIATIONS

Petroleum Equipment Suppliers Elect McKinney President

A. W. McKinney, vice president and general manager of the National Supply Company, was elected president, and W. M. Bovaird, president of Boviard Supply Company, was elected vice president by the Petroleum Equipment Suppliers' Association at its annual meeting in Colorado Springs June 7-8.

A. W. McKinney

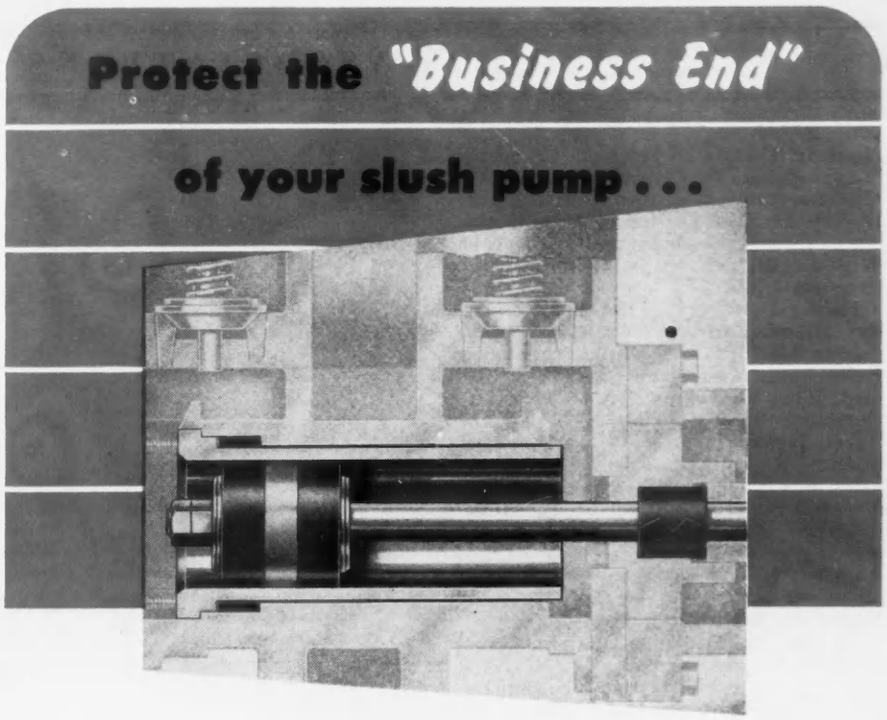
W. M. Bovaird

Directors elected are as follows:

Eastern District: George H. Alten, Alten's Foundry & Machine Works, Lancaster, Ohio; Karl Elliott, Acme Fishing Tool Company, Parkersburg, W. Va., M. L. Gentry, Utility and Industrial Supply Company, Jackson, Mich.; Jene Harper, Franklin Supply Company, Chicago; O. M. Havekotte, International Derrick & Equipment Company, Columbus, Ohio; Mason Jones, The S. M. Jones Company, Toledo, Ohio; A. S. Knowles, Parkersburg Rig & Reel Company, Parkersburg, W. Va.; Donald W. Mackie, Bradford Supply Company, Bradford, Pa.; Frederick F. Murray, Oil Well Supply Company, Dallas; A. W. McKinney, National Supply Company, Toledo, Ohio; Ferd J. Spang, Spang & Company, Butler, Pa.; and H. Bernard Wehrle, McJunkin Supply Company, Charleston, W. Va.

Mid-Continent and Rocky Mountain District: Frank E. Bernsen, Lucey Products Corporation, Tulsa; W. M. Bovaird, Bovaird Supply Company, Tulsa; E. C. Bolger, W. C. Norris, manufacturer, Tulsa; H. B. Gutelius, United Supply & Manufacturing Company, Tulsa; G. A. Hays, Hinderliter Tool Company, Tulsa; W. H. Larkin, Larkin Packer Company, St. Louis; Walter O'Bannon, Walter O'Bannon Company, Tulsa; J. L. Shakely, Jones & Laughlin Supply Company, Tulsa; Guy A. Thompson, Bethlehem Supply Company, Tulsa; Jay P. Walker, National Tank Company, Tulsa; S. P. Wallace, Maloney-Crawford Tank & Manufacturing Company, Tulsa; and Carl White Jr., Franks Manufacturing Corporation, Tulsa.

Southwestern District: Ken W. Davis, Mid-Continent Supply Company, Fort Worth; R. G. Hamaker, Reed Roller Bit Company, Houston; Frank Hereford, Murray-Brooks, Incorporated, Lake Charles, La.; Ardon B. Judd, Republic Supply Company, Houston; E. L. Lorehn, Cameron Iron Works, Houston; Fred Mayer, Continental Supply Company, Dallas; Ralph Neuhaus, Hughes Tool Company, Houston; Lip Norvell, Norvell-Wilder Supply Com-



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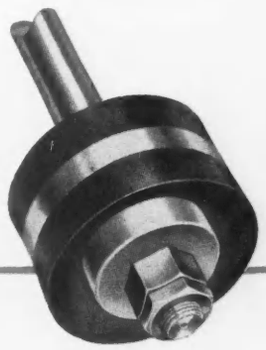
Widespread acceptance of Falcon Products in both domestic and foreign fields is your assurance of satisfactory performance.

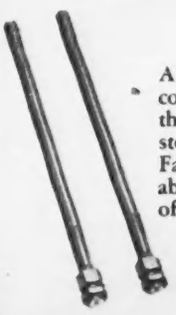


FALCON PISTONS

Heavy-duty solid type. Demountable without removing rod or piston hub. Three hub sizes accommodate pistons from 3¾" to 9¼" diameter.

FALCON LINERS

Forged from chrome-moly alloy and specially heat treated to extreme hardness, Falcon Liners are *honed* to a mirro-like microfinish. Liners and Liner Sleeves are available for every principal make of pump.



FALCON RODS

A harder surface and tougher core are achieved by Falcon through use of higher carbon steel and induction hardening. Falcon rods and packing available for all principal makes of pumps.

Sold only through leading supply houses.

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Export Representative: Guy E. Daniels, 30 Rockefeller Plaza, New York 20, N. Y.

pany, Beaumont, Texas; George O'Leary Houston Oil Field Material Company, Inc., Houston; W. Howard Pape, Jarecki Manufacturing Company, Houston; Dudley C. Sharp, Mission Manufacturing Company, Houston, and Wallace D. Wilson, Wilson Supply Company, Houston.

Pacific District: J. C. Axelson, Axelson Manufacturing Company, Los Angeles; Markley C. Brown, Hillman-Kelley, Inc., Los Angeles; J. A. Crawford, The Youngstown Steel Products Company, Los Angeles; E. S. Dulin, Byron Jackson Company, Los Angeles; Rodney S. Durkee, Lane-Wells Company, Los Angeles; D. S. Faulkner, The National Supply Company of California, Torrance, Calif.; H. H. Glen, Emsco Derrick & Equipment Company, Los Angeles; H. E. Howard, Howard Supply Company, Los Angeles; Wendell Jones, Bethlehem Supply Company of California, Los Angeles; Warner Parker, Oil Well Supply Company, Los Angeles; John J. Pike, The Republic Supply Company of California, Los Angeles; and Ted Sutter, Baker Oil Tools, Los Angeles.

Elsewhere in this issue of WORLD OIL is given a report on the important transactions of the association with reference to the International Petroleum Exposition and a report of the principal address at the meeting by L. S. Hamaker of Republic Steel Company.

The next meeting of the association will be held in the East, probably at White Sulphur Springs, W. Va.

NOMENCLATURE OFFICERS — Wilson Metcalf, The Texas Company, was elected general chairman of the Oklahoma Steering Committee of the Standing Committee on Oil Field Nomenclature of the Kansas-Oklahoma Division of the Mid-Continent Oil and Gas Association with headquarters at Tulsa, succeeding the late W. R. (Bill) Thawley. Pat M. Broach, Stanolind Oil Purchasing Company and a veteran member of the committee, was elected general vice-chairman to succeed Metcalf. In the picture, left to right, are E. L. Thomas, staff assistant, Mid-Continent Oil and Gas Association; Metcalf, Sam B. Baird, chief scout, Mid-Continent Petroleum Corporation and chairman of the Oklahoma Steering Committee; Pat M. Broach, and Lawrence R. Alley, assistant conservation director of the Oklahoma Corporation Commission and state advisor to the committee.

Gas Technology Short Course Studies Natural Gas Problems

Production and transmission divisions of the natural gas industry utilized three days of the Third Annual Short Course in Gas Technology, held June 2, 3, and 4 at Texas College of Arts and Industries, Kingsville, in the study of specific problems affecting their operations. Among the topics was that of "Automatic and Remote Control of Gas Pipe Line Flow," discussed by W. M. Moore, United Gas Pipe Line Company, who demonstrated principles involved with operating units from a typical field installation.

Centrifugal compressors as gas trunk line units were discussed from the design angle by Vandiver Mooney, Texas A. & I. engineering staff, and from the operator's viewpoint by Dan T. McDonald, Magnolia Petroleum Company. The use of this type of compressor as low pressure stage in connection with reciprocating compressors in Magnolia's Seeligson plant gave an opportunity to compare installation and operating costs of both types of equipment in like service.

Large diameter pipelines, scheduled to absorb 96 percent of pipe mill capacity for the next five years, were discussed from the construction angle by L. H. Favrot, Latex Construction Company, while Stephen D. Day, Barrett Division, Allied Chemical & Dye Corporation, covered latest developments in types and applications of pipe coatings.

"Trends in Natural Gas Cycling Operations," presented by Dr. E. O. Bennett, consulting engineer, summarized progress in maintaining and producing gas fields for maximum recovery.

Petroleum Industry Electrical Association Elects D. H. Levy

D. H. Levy, Magnolia Petroleum Company, Dallas, was elected president of the Petroleum Industry Electrical Association at its twentieth annual meeting held in Dallas in June. The meeting was also attended by members of the Petroleum Electric Supply Association and the Petroleum Electric Power Association.

Other officers elected by the Petroleum Industry Electrical Association are R. M. Slough, Ohio Oil Company, vice president, and W. H. Massey, Interstate Oil Pipeline Company, secretary-treasurer.

Photo Courtesy Oil & Gas Journal

Operating compressors in the Oil Field is pretty much of a universal job for Wisconsin Heavy-Duty Air-Cooled Engines . . . of which this Plomo Oil Company VP-4 Power Unit installation at Agua Dalco, Texas is typical.

Not only do these dependable engines provide *air to spare* for those operations calling for a continuously available source of compressed air . . . but they also supply air to *spare* for cooling the engine, at all operating temperatures. For example, a 20 H.P. Wisconsin Engine, at 1800 R.P.M., delivers 1200 cu. ft. of air per minute, at a velocity of 2480 ft. per min., providing an ample flow of accurately proportioned air around cylinders and heads, for most efficient cooling.

You can't go wrong when you specify "Wisconsin Air-Cooled Engines" for any job within a 2 to 30 H.P. power range.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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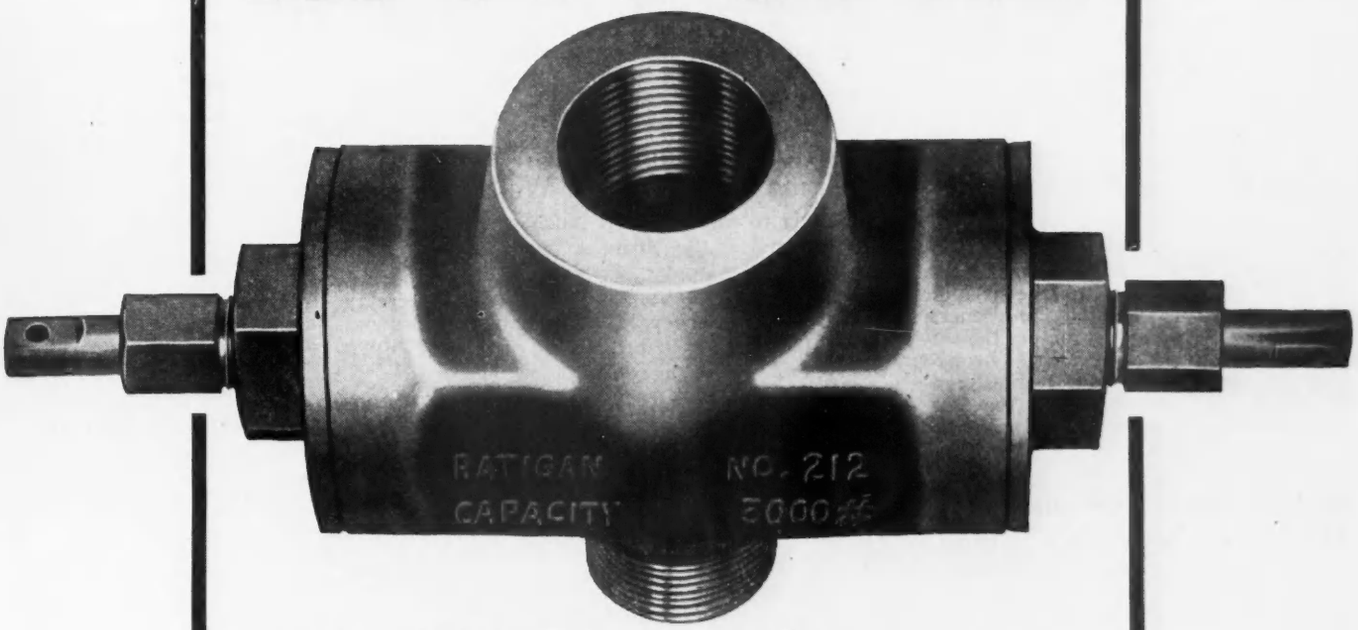


No. 212 Blowout Preventer

FOR MAXIMUM SAFETY and EFFICIENCY IN SERVICE

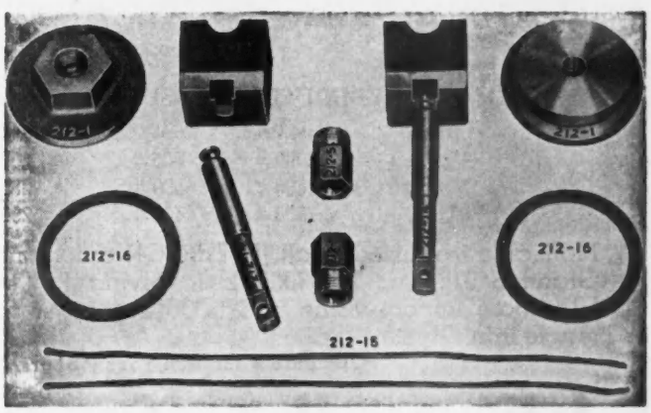
One of the outstanding devices in the oil fields, the Ratigan No. 212 Blowout Preventer embodies important advanced features essential to maximum safety and efficiency in service. Made of high pressure steel, it weighs only 41 pounds yet has a capacity of 3,000 pounds, assuring positive safety under all service conditions.

It is equipped with Ratigan new type retractable rubbers, which can be changed more rapidly by simply unscrewing the plugs at each end, when the old ones are readily accessible for replacement.

Two of these blowout preventers of the same size, with a nipple of any required length in between, make an efficient unit for swabbing. The device also can be used for running rods in wells that head or flow in the course of operation.

Made in 2½" and 3" sizes, both plain and upset. The 2½" plain type can be supplied in double-female, and if male and female are required a short nipple can be used to make the change. The 2½" upset can be supplied in male and female or double-female types. The 3" size is supplied in male and female types only; but the male connection easily can be converted to female by installing a 3" collar, making a double female unit.

Ratigan products are the result of thirty years of specialized oil field engineering experience, and are accepted leaders of their respective types. Consult the Composite Catalog for detailed descriptions, specifications and list prices.



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Ratigan Products Are Distributed Through Leading Supply Stores

Oklahoma Drilling Contractors Elect Earle Flesher Chairman

The Oklahoma City Chapter of American Association of Oilwell Drilling Contractors has elected Earle C. Flesher, Johnson & Flesher Drilling Company, as chairman. Jack Abernathy, Big Chief Drilling Company, was elected vice chairman, and Harry G. Frederickson, Grayhill Drilling Company, was elected secretary.

The 19 contractors present had as guests P. J. Phillips, University of Texas, and E. P. Chandler, Oklahoma A. & M., who talked to the chapter about supervisory training conferences. Phillips reviewed for contractors the set-up of the Accident Prevention Through Better Supervision clinics being conducted by the association in the Permian Basin, in cooperation with the State Board of Vocational Training.

Buchner Elected President of Ark-La-Tex Geophysical Group

The Ark-La-Tex Geophysical Society elected Harry M. Buchner, geophysical-geological coordinator for The Carter Oil Company, to succeed George E. Wagoner of Carter, who was the first president of the recently organized society.

L. F. Fischer, chief geophysicist for the Shreveport district of Sohio Petroleum Company, was named vice president, replacing R. M. (Dick) Wilson of The Ohio Oil Company.

Carl L. Bryan, chief geophysicist of the Shreveport district for Gulf Refining Company, is the new secretary-treasurer, succeeding J. R. Walker of Arkansas Fuel Oil Company.

Survey to Determine Amount Of Crude Under Stripper Wells

A study to find out how much crude oil lies under the stripper wells of Pennsylvania is going forward under the direction of the State Topographic and Geologic Survey, Department of Internal Affairs. William S. Lytle of the Geologic Survey is supervising the study.

J. Paul Jones of Bradford, director of production for the Pennsylvania Grade Crude Oil Association, said the information on Pennsylvania's stripper well reserves will be combined with similar data from other states to create an up-to-date picture of the stripper well reserves of the nation. The national survey, covering all wells of this type in the U. S., is being made by the Interstate Oil Compact Commission with the cooperation of the Independent Petroleum Association of America, and the National Stripper Well Association. The data to be obtained include the number of producing wells, production, productive acreage, oil reserves and related information.

National Scouts and Landmen Elect Simon Crites President

Simon Crites, Phillips Petroleum Company, has been elected president of the National Oil Scouts and Landmen's Association to succeed Howard Brooks, Magnolia Petroleum Company.

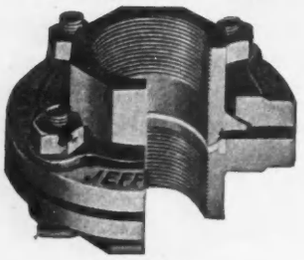
Vice presidents are R. E. Wilson, Sun Oil Company, Houston; Herman Pontius, Ohio Oil Company, Midland, Texas; and O. L. McNew, Amerada Petroleum Corporation, Casper, Wyo. Howard Pierce, Midstates Oil Corporation, Wichita, Kansas, has been elected secretary-treasurer, and W. Randy Brown, Union Sulphur Company, San Antonio, has been named editor of the yearbook.

THE OIL MAN'S CALENDAR

Aug. 30 Sept. 1	Appalachian Gas Measurement Short Course, Annual Session, West Virginia University College of Mines, Morgantown, W. Va.
SEPT. 1– 2	Oil Industry Information Committee, Minneapolis, Minn.
7– 8	American Bar Association, Section of Mineral Law, Seattle, Wash., Olympic Hotel.
7– 9	American Society of Mechanical Engineers, Fall Meeting, Portland, Ore., Reed College.
12–14	Southwest LP-Gas Convention and Trade Show, Oklahoma City, Skirvin Hotel.
14–16	Pacific Coast Gas Association, Annual Convention, Santa Cruz, Calif., Hotel Casa del Rey.
16–18	National Petroleum Association, Atlantic City, N. J., Hotel Traymore.
27–28	Independent Petroleum Association of America, Annual Meeting, San Antonio, Plaza Hotel.
OCT. 3– 6	American Society of Mechanical Engineers, Petroleum Division, Amarillo, Texas, Herring Hotel.
4– 6	American Institute of Mining & Metallurgical Engineers, Petroleum Division, Fall Meeting, Dallas, Adolphus Hotel.
4– 9	American Association of Petroleum Geologists, Midyear Meeting Pittsburgh, Pa.
4– 9	American Gas Association, Annual Convention, Technical Section, Atlantic City, Ambassador Hotel.
5– 6	Oil Industry Information Committee, New York.
11–13	American Association of Oilwell Drilling Contractors, Annual Meeting, Houston, Rice Hotel.
13–14	South Dakota Independent Oil Men's Association, Huron, S. Dak., Marvin Hughitt Hotel.
14–15	Indiana Independent Petroleum Association, Fall Convention, Indianapolis, Ind., Hotel Severin.
14–15	Texas Mid-Continent Oil and Gas Association, Annual Meeting, Fort Worth.
14–15	American Institute of Mining & Metallurgical Engineers, Petroleum Division, Fall Meeting, Los Angeles, Elks' Club.
NOV. 8–11	American Petroleum Institute, Annual Meeting, Chicago, Stevens Hotel.
MAR., 1949 24–25	New England Gas Association, Boston, Hotel Statler.

Nomads Chapter monthly meetings; **Los Angeles**, second Wednesday, Jonathan Club, B. M. Landis, Secretary. **Houston**, second Monday, Houston Club, Harry E. Estes, Secretary, Telephone Charter 4-7611. **Dallas**, L. A. Little, Secretary, Telephone Justin 8-1726. **Tulsa**, third Wednesday, Hotel Tulsa, Anthony Gibbon, Secretary, Telephone 3-1844. **New York**, first Monday, Louis Sherry's, Norris Boulden, Secretary, Telephone WIckersham 2-1311, extension 260.

Jefferson Malleable Unions



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JEFFERSON Style "B" three-piece flange union is made with brass-to-iron and iron-to-iron seats. Being made of highly refined AIR FURNACE iron, it assures you of lightweight construction, perfect ball joint, and positive seating arrangement, whether or not in alignment.

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Sizes	Test Pres.	O. W. G.	S.W.P.-550 Deg.
½" thru 4"	2000#	800#	250#
5" and 6"	1200#	500#	250#
8" and 10"	1000#	400#	250#

Malleable iron used in all JEFFERSON unions meets ASTM-4733, Grade 35018—M. T. 53000 Lbs., giving 75%-more elongation 50%-more impact value and is 30%-stronger than cupola malleable iron.

Obtainable through your jobber

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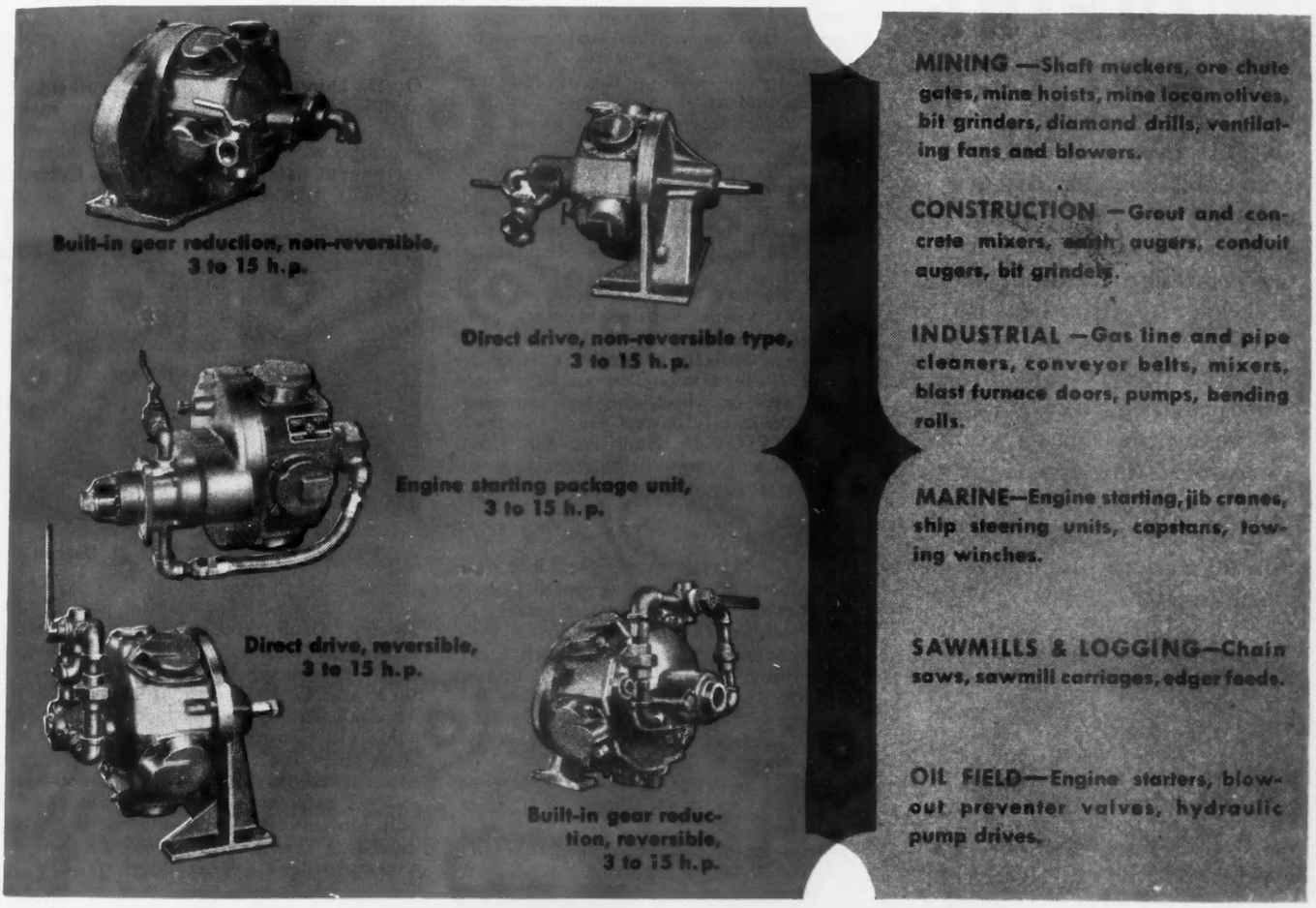
GARDNER-DENVER AIR MOTORS


Built-in gear reduction, non-reversible, 3 to 15 h.p.
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MINING—Shaft muckers, ore chute gates, mine hoists, mine locomotives, bit grinders, diamond drills, ventilating fans and blowers.

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TUBING SPIDER

• One man can easily handle this compact, lightweight Type "B" Tubing Spider. You won't have to use a sledge hammer to dislodge the slips because their narrow backs fit the tapered bowl at any normal setting level. Slips have ample size—won't crush or damage tubing. Will fit rotary table or bolt to well head; has removable gate to place around tubing.

Medium Type Tubing Spider

Heavy Type Tubing Spider

Type "B" is available with 5 slip sizes, 1" to 3". Other Guiberson Spiders are the automatic "Medium" and "Heavy" Types. For complete data see the Composite Catalog, Pages 1540-44.

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Men in the Industry NEWS

Thomas E. Sunderland has been appointed general counsel of Standard Oil Company (Indiana) to succeed **Buell F. Jones,** who died last November. **A. L. Green** has been promoted to associate general counsel. He has been senior general attorney for the company. Sunderland goes to Indiana Standard from the position of general counsel of its subsidiary, the Pan American Petroleum and Transport Company, New York. He joined Pan American in 1940, but interrupted his business career to serve as a colonel in the Army Air Forces. In the office of the Secretary of War, he had an important part in analyzing industrial plants. His knowledge of oil and synthetic oil refineries was applied particularly to selecting bombing objectives in enemy held territory. Green entered Standard's law department in 1920 after general practice and service as head of the law department for the Chicago board of local improvements. He has been a general attorney for many years. While his work with Standard has been broad in scope he is known particularly as a specialist in the law of trade marks and as supervisor of the suit in which the Indiana company successfully barred use of the trade name "ESSO" by Standard Oil Company (New Jersey) in Standard of Indiana territory.

Thomas E. Sunderland

»

James C. Martell, vice president, has been placed in charge of operations of the Coastal Oil Company, Newark, N. J. Martell joined Coastal in June, 1947, and became vice president March 1. Before joining Coastal, Martell was civilian chief of the Petroleum Requirements Section of the Fuel Division, Washington, D. C., and during the war served in the Navy as fuel officer.

»

Thomas Brownfield has been elected a director of The Carter Oil Company. He joined Carter in Tulsa in 1927 and became chief scout in 1935, remaining in that position until 1914, when he was named an executive assistant in the producing department of Standard Oil Company (New Jersey) with headquarters in New York. He rejoined Carter in 1946 and is now manager of the company's economics department and coordinator of manufacturing and marketing.

Thomas Brownfield

Dr. Harold Vagtborg, president and director of Midwest Research Institute at Kansas City, Mo., since 1945, has announced his resignation to permit him to accept an appointment as president and director of Southwest Research Institute based in Houston, director of the Institute of Inventive Research, director of the Foundation of Applied Research, and technical director of the 3500-acre Essar Ranch, all located just outside the city limits of San Antonio. All four institutions were founded by **Tom B. Slick, Jr.,** oil man and rancher of San Antonio. **Dr. George E. Ziegler,** executive scientist, will continue in this position and also will take over the administrative responsibilities of Midwest Research Institute until Dr. Vagtborg's successor is announced.

»

O. D. Donnell has retired as president of The Ohio Oil Company after more than 21 years in that office. He will continue as a director until his normal retirement date, October 1. **J. C. Donnell II,** will succeed his father as president. Other officers elected are **W. B. Emery, O. F. Moore, R. C. Gwilliam, C. Z. Hardwick,** and **G. E. McCullough,** vice presidents; **E. B. Redpath,** secretary, and **C. H. Smith,** treasurer. O. D. Donnell has been associated with The Ohio Oil Company since 1906 and president since 1927. His son began his permanent employment with the company in 1932, after his graduation from Princeton University. He was elected to the board of directors in 1936 and became vice president a year later.

J. C. Donnell

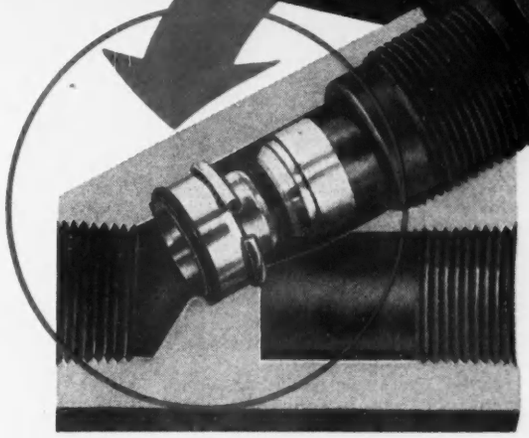
O. D. Donnell

»

Frank T. Clark, geologist in the Houston office of Cities Service Oil Company, has been appointed division geologist for the new division office opened by Cities Service in Fort Worth early in June to handle exploration activities in North and West Texas and New Mexico. **Frank Cooter,** landman at Wichita Falls, has been named division landman, and **E. J. Gemmill,** division geophysicist at Houston, has been appointed to a similar position in Fort Worth. **G. N. Shell** and **A. O. Kirkbride,** seismologists, **R. A. Nixon,** computer, and **H. L. Abbott,** draftsman, have also been transferred from Houston to the new division office.

For AIR • GAS • WATER & PETROLEUM PRODUCTS

THE NEW *Automatic* SELF-SEALING VALVE USES NO LUBRICANT SEAL



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THE *Greatest* VALVE DEVELOPMENT IN *20* YEARS

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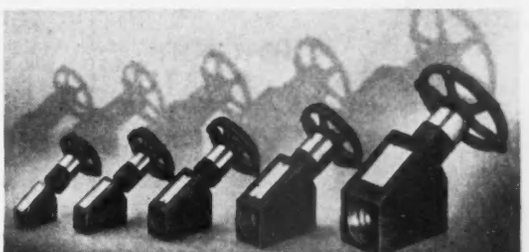
Grove Seat-Seal Valves represent the most startling development yet perfected in valve design and construction. Through a most unique arrangement, a *soft* pliable synthetic rubber ring is *pressure* sealed over dirt and solid particles, at the moment the metal valve disc is seated on its metal seat ring. As the valve is opened, the flexible rubber ring is *pressure released,* and its elastic resilience ejects any dirt. An unusual feature is the fact that the soft rubber ring is never blown away or damaged, even though the valve is opened and closed many thousands of times. A *full floating* seat ring that aligns itself to a solid non-turning plug and stem unit is employed. The valve closes in the direction of flow so that no working parts are exposed to cutting action or erosion. An encircling cap shields all threaded surfaces from paint, dirt, dust and damage. Sealed-in lifetime lubrication is *zoned* entirely away from the flowing fluid. All working parts are readily replaceable in the field without special tools.



Available in sizes from ½" to 2" Grove *Seat-Seal* Valves embody the same high standards of dependability as the widely used *Grove Regulators.* Like Grove Regulators, these valves will render years of service in hardest usage. Quick replacement of worn parts provides *the equal of a new valve* in a matter of minutes. Request Bulletin 5060.

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STEAM CONDENSERS
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FEED WATER HEATERS

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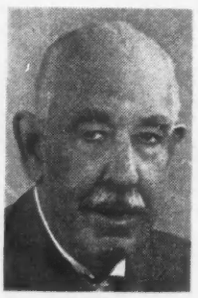
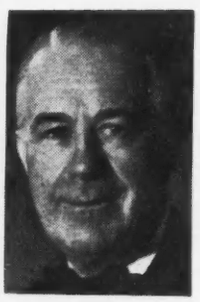
MEN IN THE INDUSTRY NEWS



W. L. Mellon

J. F. Drake

W. L. Mellon, active head of Gulf Oil Corporation for 45 years, has retired as as chairman of the board of directors. He will continue to serve as a member of the board. **J. F. Drake,** president of the corporation since 1931, will succeed Mellon as chairman of the board. **J. E. Nelson,** Gulf vice president and treasurer, has been elected executive vice president. **H. A. Gidney,** vice president and comptroller, has also been made an executive vice president. **S. A. Swensrud,** executive vice president since 1947, is new president of the corporation. **H. R. Moorhead, Jr.,** former assistant treasurer, has been elected treasurer, and **W. L. Naylor,** former assistant comptroller, has been elected comptroller. Mellon is one of the founders of the Gulf Oil Corporation and was president from 1909 to 1931, when he was elected chairman of the board of directors and appointed chairman of the executive committee. Drake, Mellon's successor, joined Gulf in 1919 as assistant to the president. He left the company in 1923, returning in 1931 as president, director, and a member of the executive committee. Swensrud, the new president, joined Gulf in 1947 as executive vice president and director.



J. E. Nelson

H. A. Gidney

S. A. Swensrud

⌄

H. H. Maddren has been elected president of Republic Petroleum Company, succeeding **C. C. Spicer,** who has resigned after heading the company since 1922. **Raymond A. Earle** succeeds Maddren as vice president. The company has holdings in California, Wyoming, and New Mexico.

C. R. Wallace, supervisor of field operations, Geophysical division, Producing department, The Texas Company, since July, 1943, has been promoted to assistant to the division manager. Wallace joined the faculty of Texas A. & M. College as an instructor in geology in September, 1930, and taught until June, 1933. He was employed by The Texas Company at Houston as an assistant computer in the Geophysical division in 1934 and assigned to a field crew operating in East Texas shortly afterward. In 1934 he was transferred to California and later was promoted to computer. Wallace was made party chief in 1936 and carried on seismic surveys in the San Joaquin and Imperial Valleys and in 1943 he was advanced to supervisor of field operations with headquarters in Houston.

⌄

Ken R. Burns has resigned from Dowell Incorporated to do consulting work as a petroleum geologist and to manage oil properties. He will make his headquarters in Tulsa, where for the past three years he has been employed in the research department of Dowell Incorporated. Before this he was service engineed for Dowell in West Texas.

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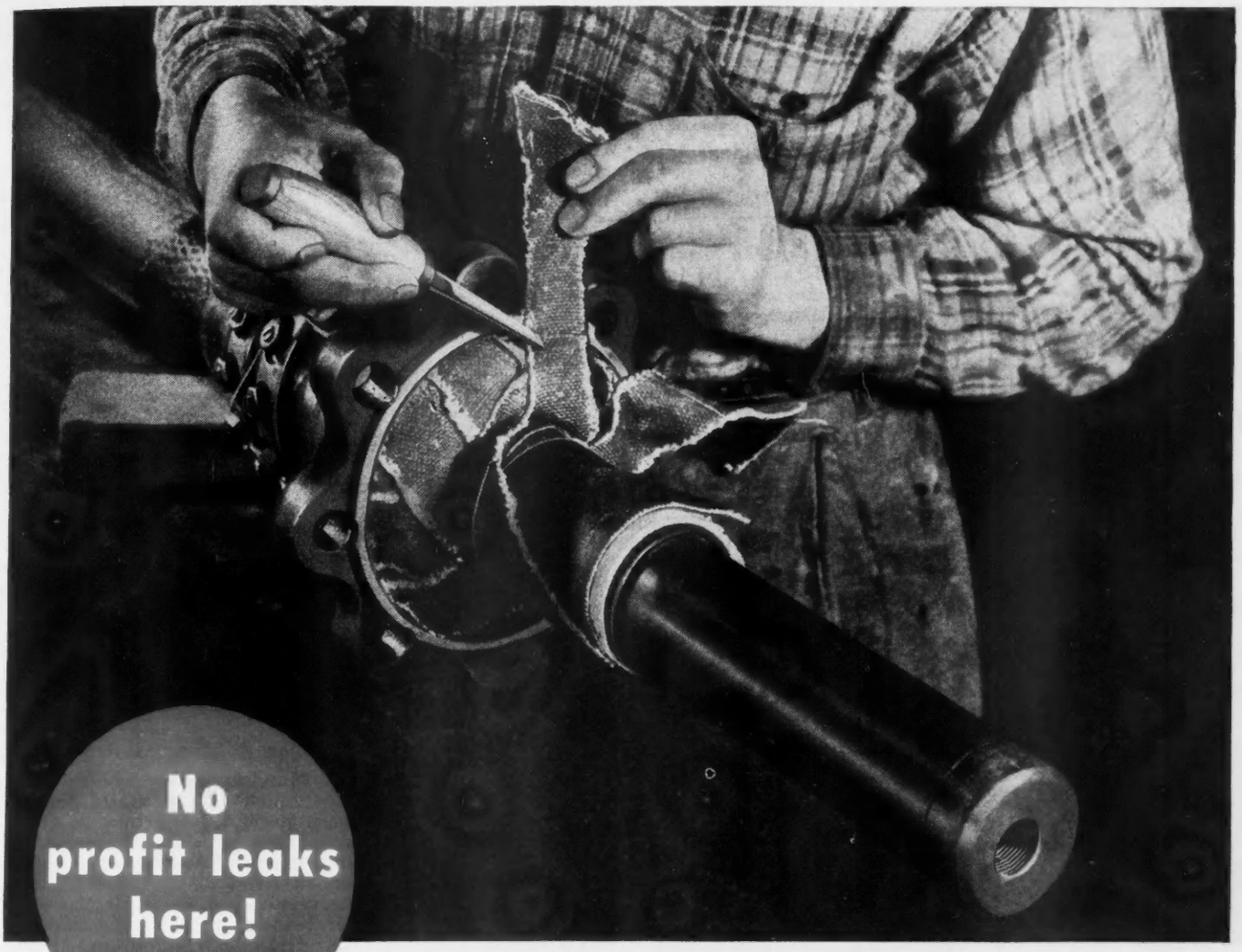

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But this profit-protection feature is only one of many which make Hewitt Rotary Drilling Hose so popular among oil men everywhere.

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2. ***Leakproof couplings!*** Hewitt built-in couplings assure unrestricted, completely rubber-lined fluidway. No external clamps!

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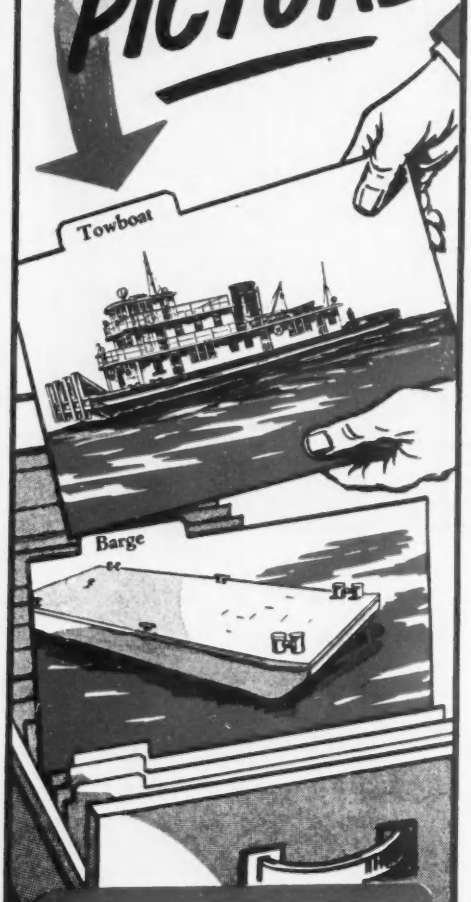

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Perry L. Nunley, district foreman for Skelly Oil Company, was awarded the new automobile given by Franks Manufacturing Corporation, Tulsa, during the International Petroleum Exposition for the best last line to a jingle describing Franks' field parts and repair service. Nunley has been with Skelly Oil for 18 years and has operated a Franks servicing unit since 1935. Frank's "last line" contest drew 3534 entries from 28 states and seven foreign countries, including Canada, Mexico, South Africa, Venezuela, Australia, Germany, and France.

Perry L. Nunley

»

Hugh L. White, former governor of Mississippi, **W. C. Leonard,** and **James McClure** have been appointed to the Mississippi Oil and Gas Board by **Governor Fielding L. Wright.** Additional appointees to the board, authorized by the 1948 State Legislature, are **William Maynard,** former assistant attorney general, and **Walter G. Johnson, Jr.,** Jackson, Miss., publisher, who were named by Mississippi's attorney general and lieutenant governor, respectively. McClure was selected chairman and Leonard vice chairman of the group. **H. M. Morse,** who served as supervisor of a former oil and gas board since 1938, was renamed as supervisor-secretary of the new board.

»

E. L. Adams has retired as vice president, director, and director of the Pipe Line department of General Petroleum Corporation. **J. L. Martin,** general superintendent of the Pipe Line department since 1932, has been elected director of the Pipe Line department and a director of the company to succeed Adams. Adams, a 1908 graduate of the University of California, joined General Petroleum in 1912 as a civil engineer on pipe line construction. He became a director in 1932 and vice president in 1936. Martin went to General Petroleum in 1913 as assistant superintendent of the Pipe Line department at Taft, following pipe line experience with other companies in Missouri, Illinois, Indiana, Oklahoma and California. He has been general superintendent since 1932.

»

Everett B. Roudebush, formerly Gulf Oil Corporation scout out of Oklahoma City, has been named chief scout for the company in the Tulsa office, succeeding the late **W. R. Thawley.** Roudebush is a native of Oklahoma and joined Gulf in 1938. He was named to the scouting division shortly afterwards and has worked in Illinois, Indiana, Michigan, and Oklahoma. He entered military service in 1943 and when discharged two years later, he rejoined Gulf and was assigned to Oklahoma City.

Transfers:

C. M. Hinton, assistant division petroleum engineer, South Texas Division, Producing Department of The Texas Company, has been transferred to Calgary, Alberta, Canada, to take charge of petroleum engineering operations for the Texaco Exploration Company. **Alvin J. Martin,** former assistant district superintendent in Illinois, has been assigned to Calgary as superintendent of field operations for Texaco Exploration Company . . . **H. R. Sharkey,** geologist for The Carter Oil Company, from Lander, Wyo., to Buffalo, Wyo. . . . **Clyde Bashara,** production engineer for Anderson-Prichard Oil Corporation, from Oklahoma City district to Hobbs, N. Mex. . . . **Robert S. Stein,** senior clerk for Phillips Petroleum Company, from Borger, Texas, to Oklahoma City . . . **Jim Karns,** Byars Drilling Company, from Winnsboro, Texas, to Oklahoma City . . . **Albert C. Greer,** petroleum engineer for Anderson-Prichard Oil Corporation, from Hobbs, N. M., to Oklahoma City . . . **G. L. Hawkins,** superintendent for Skelly Oil Company, from Guymon to Seminole, Okla.

»

Richard Mungen, senior chemical engineer for Stanolind Oil & Gas Company, has been promoted to research group supervisor and placed in charge of the chemical engineering group of the process section, Research department, Tulsa. **J. W. Hamilton,** from district landman at Shereveport, La., to division landman, Central division, Oklahoma City; **Harold F. Patterson,** from assistant seismograph party chief to seismograph party chief at Stamford, Texas; **Murry J. Flippo,** senior clerk to assistant section head, Accounting department, Tulsa; **James C. Kendall,** from group head to assistant section head, Accounting department, Tulsa; **R. F. Mathews,** senior mechanical engineer to mechanical engineering group leader, Maufacturing department, Tulsa; **Eldred E. Hancock,** from first class engineer to plant foreman, Jennings, La.; **David M. Liles,** from first class engineer at South Jennings, La., to plant foreman, Gilliam, La.; **Rexford E. Cheek,** from junior petroleum engineer, Tulsa, to field engineer, Ulysses, Kansas; **Ray S. Fellows, Jr.,** from petroleum engineer to field engineer, Alvin, Texas; **John D. Culp,** from field engineer, Hobbs, N. M., to petroleum engineer, Tulsa; **Raymond O. Courtright, Jr.,** from petroleum engineer, Odessa, Texas, to field engineer, Hobbs, N. M.; **Clarence L. Kelley,** from production foreman, Odessa, Texas, to senior petroleum engineer, Fort Worth; **Frank A. Martin, Jr.,** from petroleum engineer, Elk Basin, Wyo., to field engineer, Vivian, La.; **John E. Lang,** from field engineer, Rangely, Colo., to petroleum engineer, general office, Tulsa; **Bryan E. Mitchell, Jr.,** from junior petroleum engineer to field engineer, Liberty, Texas; **Gus F. Obenhaus, Jr.,** from junior petroleum engineer to field engineer, Lafayette, La.; **Thomas L. Cullom, Jr.,** from junior petroleum engineer, Woodsboro, Texas, to field engineer, Beaumont Texas.

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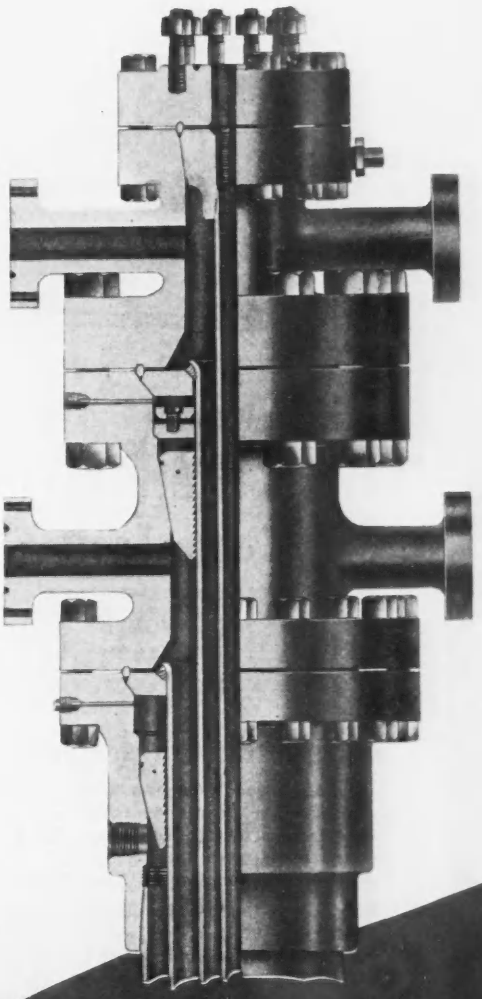

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Carl G. Herrington, assistant manager of the Production department for The Carter Oil Company, Tulsa, since December, 1947, has been promoted to manager of the department. Herrington joined Carter in 1934 and served in Oklahoma, in the Rocky Mountain district, and as division engineer at Mattoon, Ill.

Carl G. Herrington

Clarence F. Hansen has been elected president of the recently-organized Calmara Oil Company. Calmara is a wholly-owned subsidiary of the Richmond Exploration Company, which in turn is a subsidiary of Standard Oil of California. The new firm has been set up for the purpose of transporting and selling crude oil from Venezuela. Hansen has been with Standard since 1920. He became president of American Gilsonite Company, a Standard affiliate, in 1945, and for eight years previous was chief engineer of Standard's manufacturing department.

R. C. Brown has been elected vice president, director, and manager of Hudson's Bay Oil & Gas Company, Ltd., a subsidiary of Continental Oil Company Brown whose new headquarters will be in Calgary, was formerly assistant to the manager of Continental's Rocky Mountain region of the Production department in Denver, and has been an employe of Continental for nearly 24 years.

R. C. Brown

»

Dr. J. J. Mullane, assistant to the president of The Carter Oil Company at Tulsa, has been transferred to New York to serve on the staff of **John W. Brice,** coordinator of production for Standard Oil Company (New Jersey). **Dan W. Cameron,** formerly Carter chief scout, has been named assistant to the president to succeed Mullane.

»

William K. Whiteford, president of the British American Oil Company, Ltd., and of The British American Oil Producing Company of Tulsa, was elected a director of the Bank of Nova Scotia, one of the 11 national chartered banks in Canada with offices throughout Canada and in Great Britain and the West Indies. Whiteford, who is a native of Los Angeles and a graduate of Stanford University, is active in the API and a member of AIME.

»

H. H. Arnold, Jr. has been appointed manager of the Rocky Mountain division, Producing department, The Texas Company, effective June 1.

Arnold who has been assistant manager of the division since February 1, will succeed Hugh A. Stewart, who is retiring after **25 years** with the company and more than 35 years in the mining and oil industries in the U. S. and foreign countries.

H. H. Arnold, Jr.

Arnold was employed by The Texas Company at Houston in the Geophysical Department in 1927. After serving as district geologist for the company at Shawnee, Okla., he was named Oklahoma division geologist in 1938.

Returning to Texaco after the war as general superintendent of Illinois district, he was transferred to Tulsa as assistant manager, Oklahoma division, in October, 1946. He moved to Denver as assistant division manager in February.

Fig. 115
Acme Prosser Swivel Socket

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. . . As proved throughout Acme's 48-years of specializing in Trustworthy Cable Tools . . . In Rope Sockets, for instance, whose EXTRA rugged character has made them the preference of discriminating Drillers through 2-generations.

From billet to finished Rope Socket, every factor for maximum field service is safeguarded: By rigid specificatons and analyses of premium-grade, CORRECT steels; heat-treatment process, electro-automatically controlled; and, "quality-comes-first" craftsmanship.

Every Rope Socket MUST uphold the Acme tradition —for greater stamina and performance . . . Factors which mean less cost per foot of hole drilled . . . Factors which can not, in cable tool manufacture, be subjected to "stop watch" curbs.

Acme's Prosser Swivel Socket (Fig. 115) is designed for wire cable use . . . As are our Babcock (stiff) and Burns Swivel. (Other types for manila cable.) All made to API specifications — unless ordered special.

See panel (right) for other Acme Drilling Tools — for that EXTRA service you prefer.

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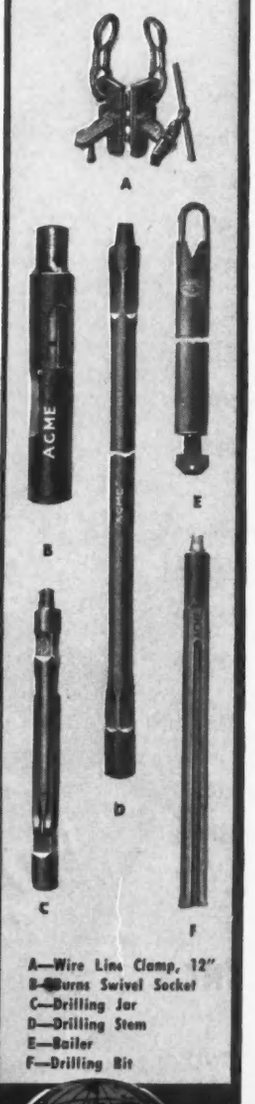

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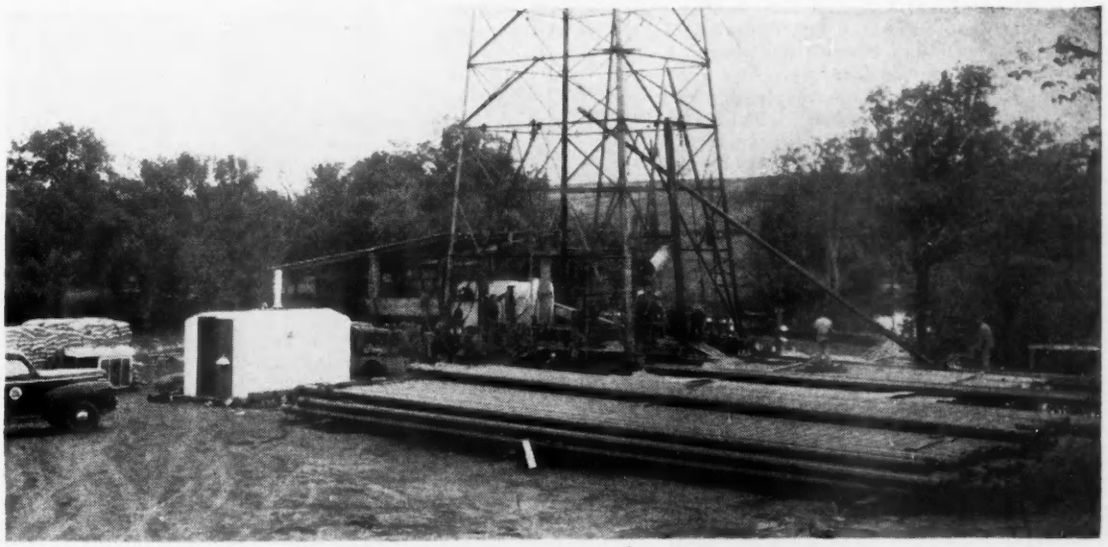

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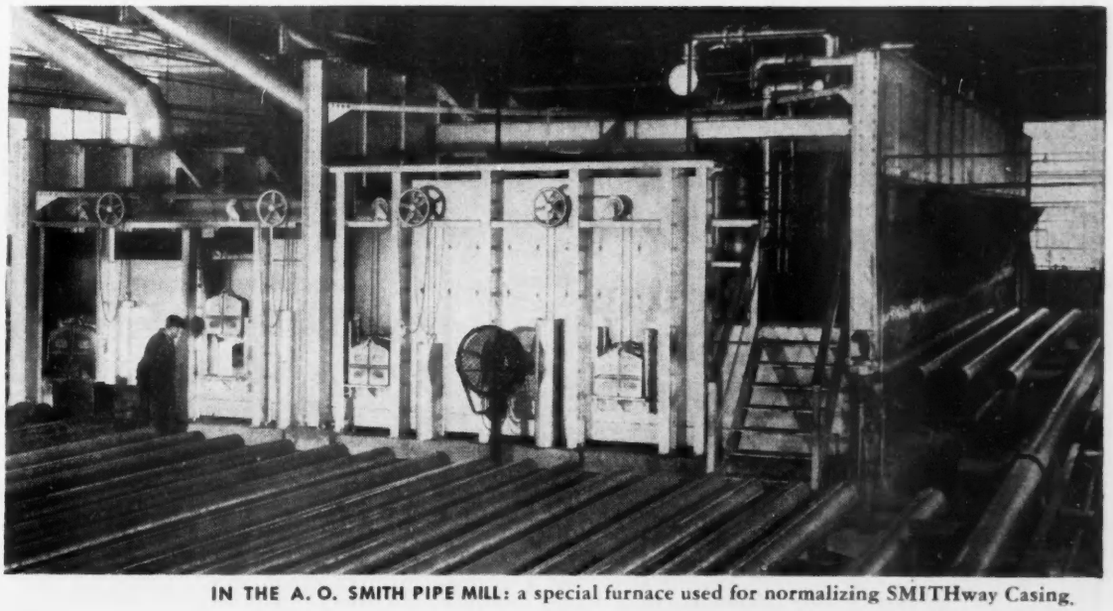

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Dr. Eugene A. Stephenson, professor of petroleum engineering and head of the Petroleum Engineering department at the University of Kansas, has resigned. Dr. Stephenson was formerly chief geologist for the South Pennsylvania Oil Company and an engineer with Ralph E. Davis, Inc. In 1930 he became professor of petroleum engineering at the University of Missouri School of Mines and Metallurgy, where he remained until he joined the University of Kansas teaching staff in 1937.

»

Dr. Robert Clinton Page of White Plains, N. Y., has been appointed medical director of the Arabian American Oil Company. Dr. Page will make his headquarters in Dhahran, Saudi Arabia, where he will supervise the company's six hospitals and numerous clinics for Americans and Arabs. He will also direct the over-all medical and sanitary programs of the company in Saudi Arabia. He was formerly assistant medical director of The Texas Company.

Dr. Robert C. Page

Wm. C. Hawk

James B. Anderson

William C. Hawk, formerly geologist for Continental Oil Company at Ventura, Calif., has been made assistant division geologist at Houston. Hawk, a native of Pittsburgh, holds a degree in geology and paleontology from the University of California. **James B. Anderson,** geologist at Los Angeles, has been transferred to Shreveport and promoted to district geologist. He succeeds **Edgar W. Kimball,** who recently went to Houston as Continental's division geologist. **Harry H. Hurd** has been promoted from geologist at Ponca City, Okla., to district geologist at Oklahoma City. He succeeds **W. Baxter Boyd,** who has been made division geologist at Fort Worth.

»

George W. Strake, oil man and philanthropist, and Mrs. Strake have given a 50-acre tract of land valued at $200,000 to the University of St. Thomas in Houston.

»

Dr. Frank S. Hudson has been named consulting geologist to Capital Company, Los Angeles. Hudson is a graduate of the University of California in the class of 1912, receiving his Ph. D. degree in 1920. He has been actively engaged in petroleum geology and engineering since that time for Union Oil Company of Delaware, The Ventura Consolidated Oil Fields, and Shell Oil Company. He has also had extensive experience in mining engineering during the war and from 1946 has been a consulting geologist.

»

L. L. Aitken, Jr., has been appointed executive assistant to **W. H. Ferguson,** executive vice president of Continental Oil Company at Denver. He has been associated with Continental as an attorney in Denver for the past ten years. He formerly practiced law as an associate of the firm of Dines, Dines and Holmes, Denver.

L. L. Aitken

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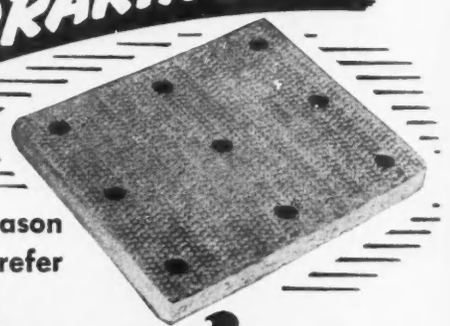

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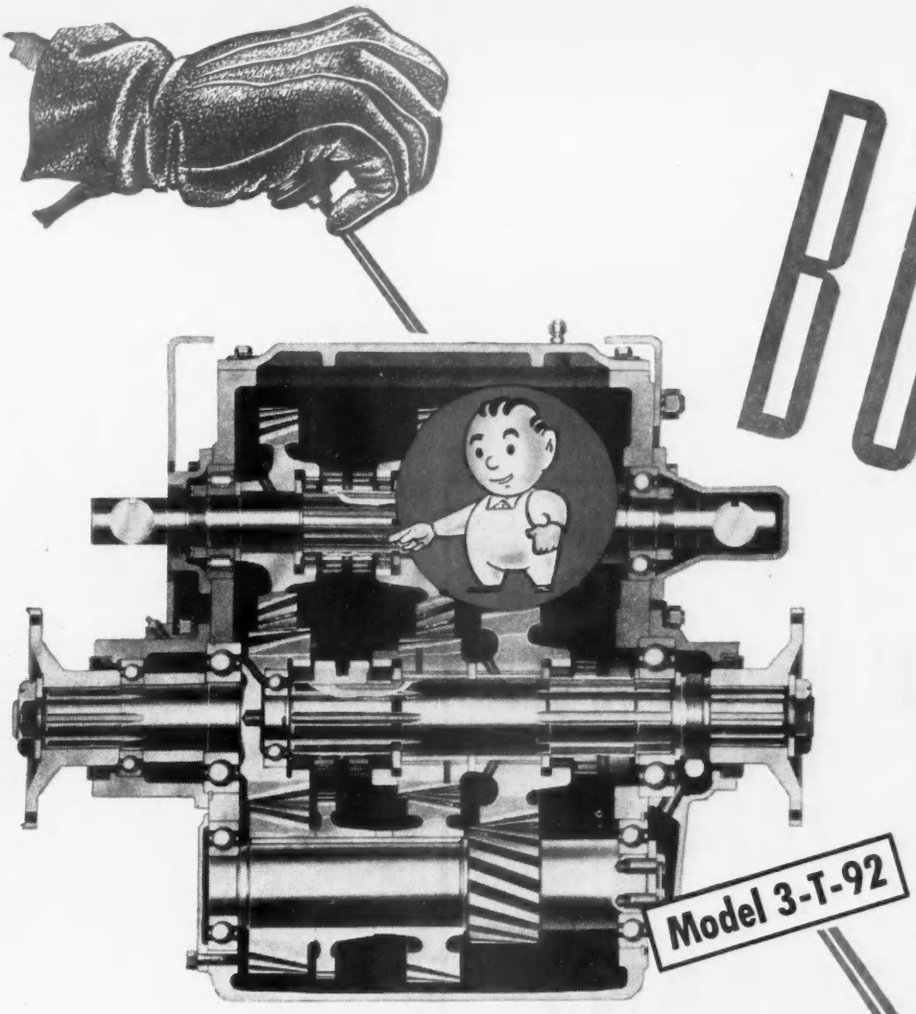

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Model 3-T-92 is also distributed through the dealer organization of
TULSA WINCH DIVISION OF VICKERS, INC.

Fuller TRANSMISSIONS

DEATHS

Herbert Milton Ash, 57, a partner in and manager of the Crown Drilling Company, died May 17 at Wichita, Kansas. He entered the oil business as a driller in West Virginia at the age of 17 and went to El Dorado, Kansas, in 1916. For 22 years he was associated with E. B. Shawver, Wichita independent operator. In 1934 he moved to Ellinwood, Kansas, and organized the Crown Drilling Company.

»

I. C. Eakin, 78, Dewey Okla., resident, died May 28 in Tulsa. He formerly was employed by the Cudahy and Tyler oil companies and was field foreman for Sinclair interests at Shidler, Okla., for a number of years.

David L. Owsley, 78, Tulsa oil man, died May 29. During his early residence in Oklahoma, he was secretary-treasurer of the old Wolverine Oil Company and served as receiver for the Sapulpa Refining Company during the early 1920's. Later he became an independent oil operator with properties near Bartlesville, Okla.

»

M. J. (Mike) Sullivan, 73, independent oil operator, died May 5 at Kansas City, Mo.

Alexander Scott Donnelly, 75, former division production superintendent of the Kansas-Oklahoma Division of The Texas Company, died May 28 at Hays, Kansas. He joined The Texas Company in the early days of the Glenn pool and was active through the development of Cushing, Seminole, and Tonkawa. He was division production superintendent in Tulsa at the time of his retirement in 1934.

»

Ralph A. Hantzsch, 51, manufacturing superintendent in the Shell Oil Company's exploration and production research laboratory in Bellaire, Texas, died May 27. Hantzsch, who had been with Shell for the last ten years, was formerly associated with The Edison Company in Orange, N. J. He held an electrical engineering degree from the University of Wisconsin, where he also served as an instructor. He was a member of the American Chemical Society, the Institute of Radio Engineers, and the American Petroleum Institute.

Ralph A. Hantzsch

»

Raymond T. McNally, 48, former Tulsa oil man, died May 22. He was widely known in Oklahoma and Kansas, where he operated as an independent producer.

»

Frank M. Donovan, 70, retired Stanolind Pipe Line Company employe, died May 5 at Tulsa. He had been with Stanolind for 20 years prior to his retirement in 1943. He was previously connected with the Cosden Oil Company.

»

E. D. Erwin, 63, veteran Mid-Continent Petroleum Company field auditor, died May 24. A resident of Tulsa since 1916, he had been affiliated with Mid-Continent for 28 years.

»

James W. Sheridan, pioneer Oklahoma oil operator and a former Tulsa, Okla., resident, died May 4 at his home at Mattoon, Ill., following a heart attack. He went to Oklahoma about 1915, residing at Okmulgee and later in Tulsa and Wichita, Kans., moving to Illinois about seven years ago.

»

Fred L. McDaniels, superintendent of production for Midstates Oil Corporation, Tulsa, died May 13. He was a native of Cochranton, Penn., and entered the oil business in 1901 in West Virginia. He moved to the Mid-Continent region in 1905 and was connected with Prairie Oil and Gas Company and The Texas Company. He had been affiliated with Midstates for 23 years.

»

Glenn Skinner, 70, general manager and vice president of Black, Sivalls and Bryson, Inc., died May 7. He joined the firm 40 years ago as a general office clerk at Bartlesville, Okla., and remained in that office until 1927 when he was appointed branch manager at Tulsa. Seven years later he was transferred to Oklahoma City, where he lived until his death.

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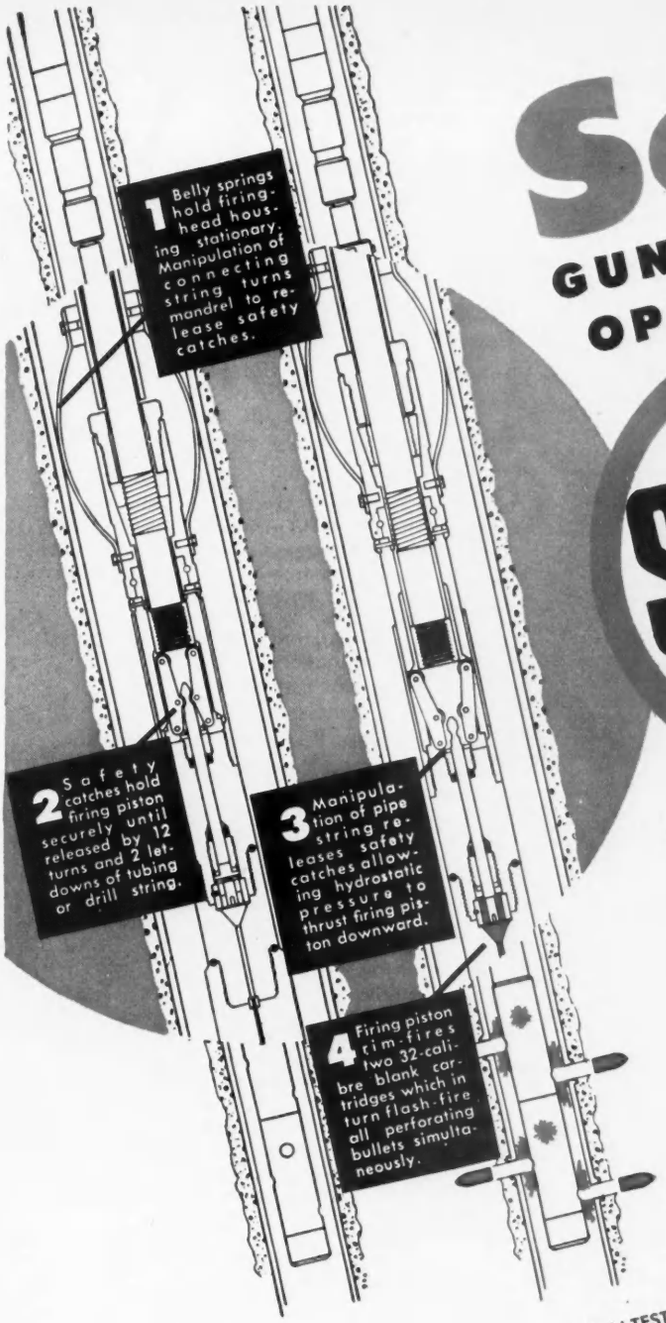

1 Belly springs hold firing-head housing stationary. Manipulation of connecting string turns mandrel to release safety catches.
2 Safety catches hold firing piston securely until released by 12 turns and 2 let-downs of tubing or drill string.
3 Manipulation of pipe string releases safety catches allowing hydrostatic pressure to thrust firing piston downward.
4 Firing piston rim-fires two 32-calibre blank cartridges which in turn flash-fire all perforating bullets simultaneously.

The "SHOOT-N-TEST" Gun Perforator Firing-Head ready to fire.

The "SHOOT-N-TEST" Gun Perforator at the moment of fire.

THE JOHNSTON ALL PURPOSE GUN PERFORATOR

THE JOHNSTON "SHOOT-N-TEST" Gun Perforator provides complete safety in every phase of gun perforating operations —maintenance, transportation to and from well, rig-floor handling and running in the well. The "SHOOT-N-TEST" fires *only* when subjected to *both* in-the-hole hydrostatic pressure and precise top-hole manipulation of the tubing or drill string by the driller.

Many advanced features are embodied in the Johnston "SHOOT-N-TEST" Gun Perforator to make it the ideal choice for operators desiring the utmost safety and efficiency in perforating and formation testing equipment . . .

POSITIVE FIRE of all bullets is assured by the flash-hole design of the perforating gun bodies.

EXACT POSITIONING in zone to be perforated is determined by actual pipe-in-the-hole tally.

SELECTED NUMBER OF PERFORATIONS is determined by the number of 4, 5 or 6-shot perforating gun body sections attached to the firing-head.

A MINIMUM OF EXPENDABLE PARTS for each perforating job. No extra equipment other than the "SHOOT-N-TEST" Firing-Head, the Perforating Gun Body Sections and a minimum of reloading supplies is needed.

Write for new descriptive folder!

FOR PERFORATING CASING AND TESTING FORMATION IN ONE RUN

By unitizing the Johnston "SHOOT-N-TEST" Gun Perforator with a regular Johnston Formation Tester Assembly, any designated formation can be perforated and tested in one round trip of tubing or drill string. A quick, efficient method of obtaining water shut-off information, doing exploratory work or testing for actual production.

SHOOT-N-TEST Trademark FORMATION AND CASING TESTING JOHNSTON

M. O. JOHNSTON OIL FIELD SERVICE CORP.
3035 Andrita Street, Los Angeles 41, California
"Servicing California-Permian Basin-Rocky Mountain Areas"

BRANCHES
BAKERSFIELD, CALIFORNIA • AVENAL, CALIFORNIA
SACRAMENTO, CALIFORNIA • VENTURA, CALIFORNIA
SANTA MARIA, CALIFORNIA • ODESSA, TEXAS • CASPER, WYOMING • HOBBS, NEW MEXICO

JOHNSTON OIL FIELD SERVICE CORP.
5702 Navigation Boulevard, Houston, Texas
"Servicing Mid-Continent and Gulf Coast Areas"

BRANCHES
ALICE, TEXAS • VICTORIA, TEXAS • WICHITA FALLS, TEXAS
GRAHAM, TEXAS • TYLER, TEXAS • FERRIDAY, LOUISIANA
LAKE CHARLES, LOUISIANA • SHREVEPORT, LOUISIANA
LAUREL, MISSISSIPPI • MAGNOLIA, ARKANSAS
CHICHASHA, OKLAHOMA

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

L. E. Vessels

Larkin Packer Company Opens Wichita Falls Warehouse; L. E. Vessels Named District Sales Representative

A greatly expanded warehouse was recently completed by Larkin Packer Company, Inc., at 413 East Scott, Wichita Falls, Texas, in order to better serve the North Texas, Panhandle, and Southern Oklahoma area. L. E. Vessels has been named the district Larkin sales representative for the Wichita Falls area.

The Larkin warehouse is a 40x80-foot quonset-type building. The building includes warehouse and office space as well as living quarters for the Larkin warehouse representative, Jim Ellis.

Larger stocks of Larkin cementing and production equipment will be carried in the new location. The new Wichita Falls location is in addition to other Larkin warehouses at Houston, Corpus Christi, Odessa, Shreveport, Tulsa, and Great Bend.

Before he joined the Larkin sales organization, Vessels represented various oil tool manufacturers in South America. He has also been store manager for Wilson Supply Company at Harvey, La., and was employed prior to that by the American Iron and Machine Company, Harvey.

Northcutt Named Superintendent Of Halliburton's East Texas Division

Hubert Northcutt, superintendent of the Eastern Division of the Halliburton Oil Well Cementing Company with headquarters at Flora, Ill., has been transferred to Dallas where he will take charge of the East Texas Division.

Robert W. Mitchell, former assistant superintendent of the Eastern Division, has been promoted to superintendent of that division and will maintain headquarters at Flora, Ill.

H. P. Hearn, former superintendent of the East Texas Division, has been transferred to Denver, where he will assume the duties of superintendent of the Rocky Mountain Division.

C. O. Pace, who was formerly superintendent of the Rocky Mountain Division, has taken a temporary sick leave.

Barkley Appointed Sales Manager For Raybestos-Manhattan, Inc.

Littleton C. Barkley has been appointed general sales manager, asbestos and rubber products, West Coast division, Raybestos-Manhattan, Inc. Barkley, who has been with the Manhattan Rubber Division for 23 years, has been until recently its sales manager for mechanical rubber products, in which capacity he has spent much time with industrial distributors on the Pacific Coast. Prior to his last position he was manager of Manhattan's New York Branch for several years.

W. R. Persons and K. F. Steingass Elected to Lincoln Electric Board

W. R. Persons, general sales manager, and K. F. Steingass, superintendent of electrode manufacture, have been elected to the board of directors of Lincoln Electric Company.

Persons has been associated with Lincoln since his graduation from Case Institute of Technology in 1932. Prior to his appointment as general sales manager in 1946, he was the Pittsburgh district manager.

Steingass was first employed for several years in plant supervision at the Grasselli Chemical Division of the E. I. DuPont De Nemours Company.

Paul H. Shepherd Appointed Assistant Treasurer of Oil Well Supply Company

Paul H. Shepherd, manager of Oil Well Supply Company's Gulf Coast Division since May, 1945, has been appointed assistant treasurer and will be located in the company's headquarters at Dallas.

Shepherd has been connected with Oilwell for 32 years, starting as a bookkeeper at Winchester, Ky., in 1916. He served successively as store manager, district manager and assistant division manager and was located in Illinois, Louisiana, Wyoming and Texas, prior to his appointment as Gulf Coast division manager in 1945. In 1944 he served with PAW in Washington.

Charles R. Barton Retires From National Supply Company Service

Charles R. Barton, vice president in charge of manufacturing for The National Supply Company, has retired after 30 years of service. Barton has been a prominent figure in manufacturing circles of this area for nearly 40 years. After attending Purdue university and Carnegie Institute of Technology, he became associated in 1909 with the National Tube Company in Ellwood City, Pa. He rose from foreman on the piercing and rolling mill to assistant general superintendent in 1914.

Charles R. Barton

He became general superintendent of the Standard Seamless Tube Company at Ambridge, Penn., in 1918 and, ten years later, when that company was acquired by Spang-Chalfant & Company, he was elected vice president in charge of operations and a director of the latter company.

Since 1937, when Spang-Chalfant was consolidated with The National Supply Company, he has been a vice president and director. In 1940 he was placed in charge of all manufacturing operations of National Supply's six plants in this country.

Bethlehem Supply Company Plans To Enlarge Tulsa Plant Facilities

The Bethlehem Supply Company of Tulsa plans to add 24,275 square feet of floor space to its present plant to be used for welding and fabricating, while space now assigned to those activities will be devoted to other work. Date when construction will get under way has not been announced but company officials hope to have the new building completed before the end of the year.

men who know the ropes...
take
EXCELLAY PREFORMED
Tiger Brand
every time!
● Yes, the Big Demand is for TIGER BRAND . . . because U·S·S American TIGER BRAND Rotary Lines are famous for their smooth, trouble-free performance and long, low-cost service life!
Made of uniformly high quality steel wire to close tolerances, TIGER BRAND gives you strength, toughness, and flexibility . . . *in the right combination* . . . to stand up tirelessly under the most difficult working conditions. You'll find this more supple rope easier and safer to handle, too. It has less tendency to kink and snarl . . . and, even when broken, crown wires remain in place and do not porcupine out to injure riggers . . . advantages which save time, trouble, and money any way you figure them!
Your wire rope supplier can give you immediate delivery on any amount of TIGER BRAND you need. Anticipate your requirements. Keep plenty on hand. Don't get caught with your lines down!
AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York
COLUMBIA STEEL COMPANY
San Francisco
United States Steel Export Company, New York
UNITED STATES STEEL
USS
AMERICAN
TIGER BRAND
WIRE ROPE
UNITED STATES STEEL
EXCELLAY PREFORMED
THE BIG DEMAND IS FOR TIGER BRAND

Macwhyte Company Appoints Minton Gulf Coast Factory Representative

W. Howard Minton has been appointed factory representative for Macwhyte Company. Minton will headquarter in Houston and travel the Gulf Coast Area.

He has spent many years in Texas fields on varied lines of equipment. He now represents Macwhyte Company and Macwhyte wire rope and slings exclusively.

W. Howard Minton

Lester Selig Elected Board Chairman By General American Transportation

Lester Selig, who started work with the General American Transportation Corporation 33 years ago, has been elected chairman of the board. Max Epstein, who has been chairman, was elected chairman of the executive committee.

After some time in the Warren, Ohio, and East Chicago, Ind., plants, Selig rose through the Accounting and Purchasing departments to appointment as assistant superintendent at East Chicago. In 1919, after active service abroad in the armed forces during World War I, he was named assistant to the president and in 1931 was elected president. He was elected vice chairman of the board in 1945.

John P. McFadden of Rockville Center, Long Island, was elected director and vice president of the company, to succeed Bennett Epstein, retired. McFadden has been with General American for 33 years. Howard C. Westfall, eastern manager for the Tank, Storage Terminal division of the company, was elected assistant secretary.

American Manufacturing Company Of Texas Appoints John R. Castle

John R. Castle has been appointed export sales representative for the American Manufacturing Company of Texas with offices at 475 Fifth Avenue, New York. Castle became connected with this company in 1942, and after spending some time in the plant was placed in charge of the Houston office.

John R. Castle

Minneapolis-Honeywell Regulator Firm Fills Five Sales Managerial Positions

Kent L. Wilson has been promoted to southwest region manager for the Minneapolis-Honeywell Regulator Company, with headquarters in Dallas. A graduate of the University of Minnesota where he received an engineering degree, Wilson joined Honeywell as a student engineer in 1935. The Southwest region, which he now heads, covers all of Texas and surrounding areas and includes branch offices in Dallas, Houston, New Orleans and Wichita. Wilson succeeds Karl W. Schick, resigned.

Succeeding Wilson in Detroit is T. S. Carley, who has been sales manager of the stoker and wholesale divisions at the home office. Carley joined Honeywell in 1935 in the production department as an apprentice and in 1939 was transferred to sales and subsequently moved to San Francisco as a sales engineer. In 1944 he was returned to Minneapolis to the position he held until his latest promotion.

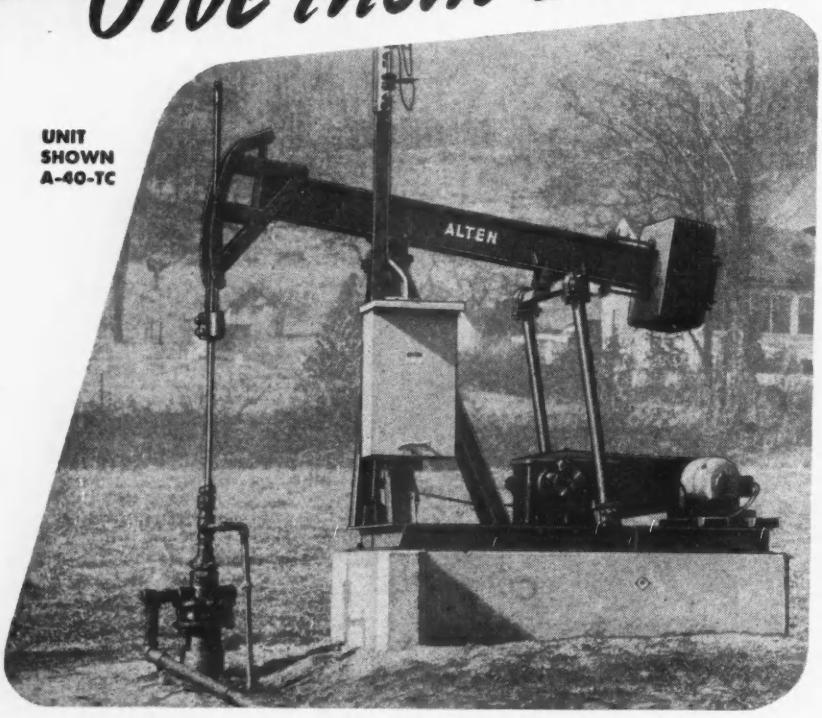
Walter J. Baak, who has been sales manager of the midwestern region, with headquarters in Chicago, has been promoted to sales manager of the wholesale division. Baak joined Honeywell in 1935.

G. M. Kingsland, who has been heading sales activities of the company's control devices and specialties departments, is taking over new duties in the heating controls division. His immediate responsibility will be to head up sales activities of the stoker controls division.

William S. Robards has been appointed Milwaukee branch manager. He succeeds L. C. Johnson, who died in May. Robards has been in the Milwaukee office since 1944 in charge of industrial division sales. Prior to that, he had spent eight years in St. Louis after completing his Honeywell training program and serving some time as a field engineer.

ALTEN PUMPING UNITS

Give them a trial!



UNIT SHOWN A-40-TC

Quality Features Include:

★ High Capacity Double-Reduction Gear Reducer Chrome-Nickel Steel Pinions. Hardened Steel Gears. Helical Shaved Gearing. Roller Bearing Equipped Throughout.

★ Double-Row, Spherical Self-Aligning Wrist Pin and Equalizer Roller Bearings.

★ Rigid, All-Welded, Structural Steel Samson Post and Frame

★ Adjustable Stroke Lengths, Effective Balancing, For Use With Gas Engine or Electric Motor.

★ High Efficiency. Weatherproof Construction.

SEND FOR New CATALOG

Complete Pumping Unit Specifications. Also illustrates Alten Casing Heads, Stuffing Boxes, Stop Cocks and hundreds of other production items.

ALTENS
FOUNDRY AND MACHINE WORKS, INC.
LANCASTER, OHIO
Established 1889
Sold Through Dealers Everywhere

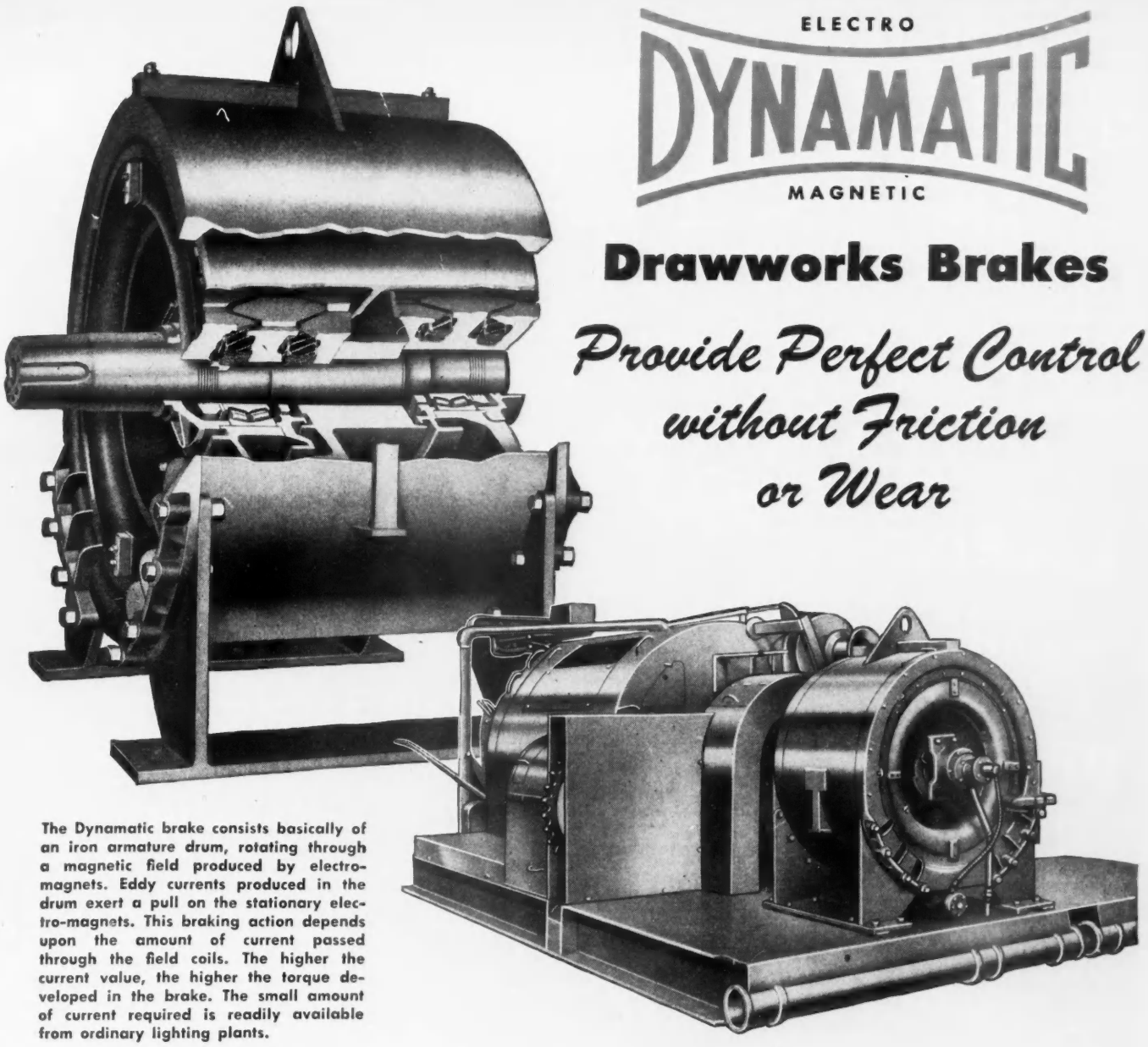
ELECTRO

DYNAMATIC

MAGNETIC

Drawworks Brakes

Provide Perfect Control without Friction or Wear



The Dynamatic brake consists basically of an iron armature drum, rotating through a magnetic field produced by electro-magnets. Eddy currents produced in the drum exert a pull on the stationary electro-magnets. This braking action depends upon the amount of current passed through the field coils. The higher the current value, the higher the torque developed in the brake. The small amount of current required is readily available from ordinary lighting plants.

THE Dynamatic electro-magnetic drawworks brake provides a braking effect which is variable and controllable through a range from 800 rpm to a drum speed slow enough to set slips on the heaviest strings of drill pipe or casing, without the assistance of the friction brake. Mounted similarly to the hydraulic type brake, the Dynamatic drawworks brake is comparable in size and weight. Energy absorbed by the brake is converted into heat, and dissipated in the cooling water. Remote control at the driller's position permits ease and speed of operation.

Outstanding characteristics of the Dynamatic brake are high torque at low speeds, and the complete absence of friction or wear, except on bearings, which have been designed oversize to permit continuous operation for years.

The Dynamatic brake is readily applied to practically all drilling rigs.

Sales Representatives: **GRIBBIN AND BAYLOR** Los Angeles • Houston • Fort Worth

DYNAMATIC **CORPORATION** • KENOSHA, WISCONSIN

Subsidiary of **EATON MANUFACTURING COMPANY** *Cleveland, Ohio*

General Offices: CLEVELAND, OHIO. *Plants:* CLEVELAND • MASSILLON • DETROIT • SAGINAW
BATTLE CREEK • MARSHALL • VASSAR • KENOSHA • WINDSOR (CANADA)

Oil Well Supply Company Appoints Store Managers in Kansas, Oklahoma

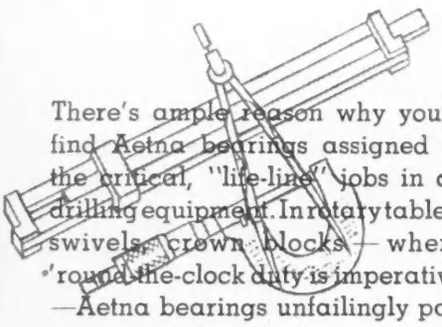
Ralph H. Coplin, storeman at the McPherson, Kansas, Oil Well Supply Company store since January 1, 1948, has been appointed manager of that store. He formerly was connected with Oilwell stores at El Dorado and Ellinwood, Kansas. He succeeds Clarence W. Morrison, Jr., who has transferred to Wewoka, Okla., as store manager. Morrison served in the Russell, Kansas, store prior to joining McPherson store.

C. E. Lance, Wewoka, Okla., store manager for the past year, has been appointed store manager at Seminole, Okla. He succeeds G. T. Way, who has transferred to the company's Gulf Coast Division as manager of the Natchez, Miss., store. Lance was located at stores in St. Elmo, Clay City and Carmi, in Illinois, before serving three years with the Navy in the recent war. He rejoined Oilwell at the Seminole, Okla., store in November, 1945, and became manager at Wewoka, Okla., in May 1, 1947.

Way has been with Oilwell for 28 years. He served in stores at McPherson, Kansas, and Fairfax and Okmulgee, Okla., before going to Seminole as manager in May, 1943.

Aetna BEARINGS ARE ENGINEERED TO CUT DRILLING COSTS

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings



There's ample reason why you'll find Aetna bearings assigned to the critical, "life-line" jobs in oil drilling equipment. In rotary tables, swivels, crown blocks — where 'round-the-clock duty is imperative — Aetna bearings unfailingly pay off . . . avoid costly down-time . . . pare down maintenance expense . . . stretch equipment life.

For your next *vital* applications, SAVE WITH AETNAS . . . the bearings custom-engineered to the *extra* capacity and endurance requirements of oil country machinery.

AETNA BALL AND ROLLER BEARING CO.
4600 Schubert Avenue
Chicago 39, Illinois

Write for Engineering Catalog and name of nearest field engineer.

EQUIPPED FOR SIZES UP TO 38 INCHES O. D.

Aetna
BALL AND ROLLER BEARINGS

Byron Jackson Company Names Mid-Continent Representative

Steve K. Williamson has been appointed sales representative for Byron Jackson Company, Oil Tool division, in the Mid-Continent area.

S. K. Williamson

Williamson has worked in the oil fields most of his life and has recently completed an intensive sales and service training course in the Oil Tool Plants. He will be in charge of the Tulsa office, Thompson Building, and will also cover the eastern Oklahoma and Kansas territories.

Assistant General Manager for Koppers Company Division Named

Lenvik Ylvisaker has been named assistant general manager of the Piston Ring Division of Koppers Company, Inc. He will move to the division offices in Baltimore from Pittsburgh, where he has been assistant production manager for Koppers.

Dr. T. C. Jarrett has been appointed manager of the Enginering and Development Department of the division. Dr. Jarrett, who has been chief metallurgist of the division since 1941, will be responsible for all research and engineering.

E. S. Freeman, Jr., has been transferred to the Sales department, R. R. Jackson has been appointed general superintendent of shops, J. J. Nolan has been named superintendent of Plant 1, and J. Rehmert has been made superintendent of Plant 2 for Koppers.

Texas Sales Position Filled by Minnesota Mining, Manufacturing

Appointment of James A. McRae of Houston as "Coro-Gard" sales engineer has been announced by the adhesives and coatings division of Minnesota Mining and Manufacturing Co., St. Paul, Minn.

James A. McRae

McRae, introducing the firm's anti-corrosion coating for oil tank interiors, will concentrate on the Midland-Odessa fields.

The coating was announced in January after four years of laboratory and field tests. It withstands corrosive effects of sour crudes at least two years without maintenace, the firm reported.

McRae, 28, a Marine Corps veteran, first worked in the oil fields summers as a roughneck, while attending Southern Methodist University at Dallas. After the war he worked two years as a bidder and estimator on oil field contracting and construction.

Take it from every angle . . .

MANHATTAN'S NEW RAY-MAN Rotary Hose is your best investment

SIX MAJOR FEATURES

- ✓ Has more flexibility
- ✓ Holds steady in the derrick—resists pulsation under pressure
- ✓ Lasts longer because of balanced, engineered construction
- ✓ Handles easier in moving from hole to hole with less likelihood of damage
- ✓ Has G.O.P. Flexlastics tube for all methods of drilling, including drilling-in with oil or oil-base mud
- ✓ Has new Built-In Coupling with leak-proof "Lip-Lok" Seal

Manhattan engineers have developed equipment to wind high tensile steel-wire under precisioned tension. This makes possible the new Ray-Man Rotary Hose construction.

The New Built-in Type "E" Coupling is streamlined and leakproof. It has the new "Lip-Lok" Pressure Sealing Flange (Feature "A" in illustration) which provides positive leakproof assurance.

Check construction from every angle, and you see the reason Manhattan can't let you down. Field reports, laboratory research and experienced hands on the manufacturing controls keep Manhattan Ray-Man Rotary Hose safely ahead of changing oil field conditions. It's balanced-built from "Standpipe to Swivel."

Ray-Man is made for 5,000 lbs. test pressure. The same type in Paranite Brand is made for 4,000 lbs. test pressure.

RAYBESTOS R M MANHATTAN

RAYBESTOS-MANHATTAN INC.

Keep Ahead with Manhattan

MANHATTAN RUBBER DIVISION **PASSAIC, NEW JERSEY**

Link-Belt Company Lets Contract For New Plant, Factory, and Offices

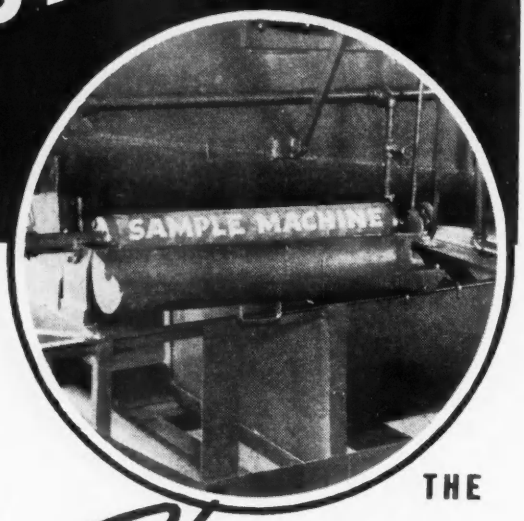
Link-Belt Company has announced that it has given Vivrett & Vivrett the contract for the construction of a new plant on a ten-acre plot of ground on Wayside Drive in Houston. J. A. Pitzinger is the architect and engineer for the new plant.

Included in the project will be a one-story, all-steel factory building with three bays, and a two-story office section of masonry construction in front. The plant proper will include a modern machine shop, structural steel shop and large warehousing facilities. It will comprise approximately 45,000 square feet of floor space.

Dwyer Promoted to California Sales By Byron Jackson Oil Tool Division

George D. Dwyer, former manager of the export order department, has been promoted to California Sales by the Oil Tool Division of Byron Jackson Company. Dwyer joined Byron Jackson in 1941 and returned as expediter after army service.

TRUE SAMPLES



Economical

Get true samples instantly—without interfering with drilling operations! No expensive slow-down . . . no special equipment or technicians needed. Thompson Sample Machine is operated by simple hand lever. Pays for the entire separator in a short time.

THE Thompson SHALE SEPARATOR AND SAMPLE MACHINE

Engineered to be operated by the slightest flow of mud, with capacity to handle extreme pressures and volume from the deepest wells! Only *clean mud* goes back into the well. No abrasives to wear out equipment. Standard equipment on every model, the SAMPLE MACHINE gives accurate foot-by-foot samples of cuttings. Your order can be filled today.

THOMPSON TOOL CO.
IOWA PARK, TEXAS

North Texas Representatives Named by Technical Oil Tool

R. K. Palmer, field engineer, is serving users of Totco Recorders for controlled vertical drilling in North Texas and South Oklahoma fields, with headquarters at Duncan. Hugh Weathersby has been serving for over a year in the same field engineering job in West Texas, and makes his headquarters at Odessa.

Hugh Weathersby

R. K. Palmer

Expansion of the field engineering staff of Technical Oil Tool Corporation, Ltd., to keep pace with the steadily increasing number of Totco Recorders in use in active drilling areas has been a major objective of the company since normal production of Totco equipment was resumed after the war's end.

Luscombe Airplane Corporation Begins Deliveries on 1949 Models

Luscombe Airplane Corporation, Dallas, has begun deliveries on its 1949 Model Silvaire Deluxe, which has been completely restyled inside and out. Thirteen major changes have been incorporated into the new model.

Seats have been redesigned to provide maximum relaxation with deep foam rubber cushions and form fitting seat backs. The cabin area is soundproofed with fiberglass material and stainless steel mufflers have been added. Two ventilators and a cabin heater provide fresh air and warmth.

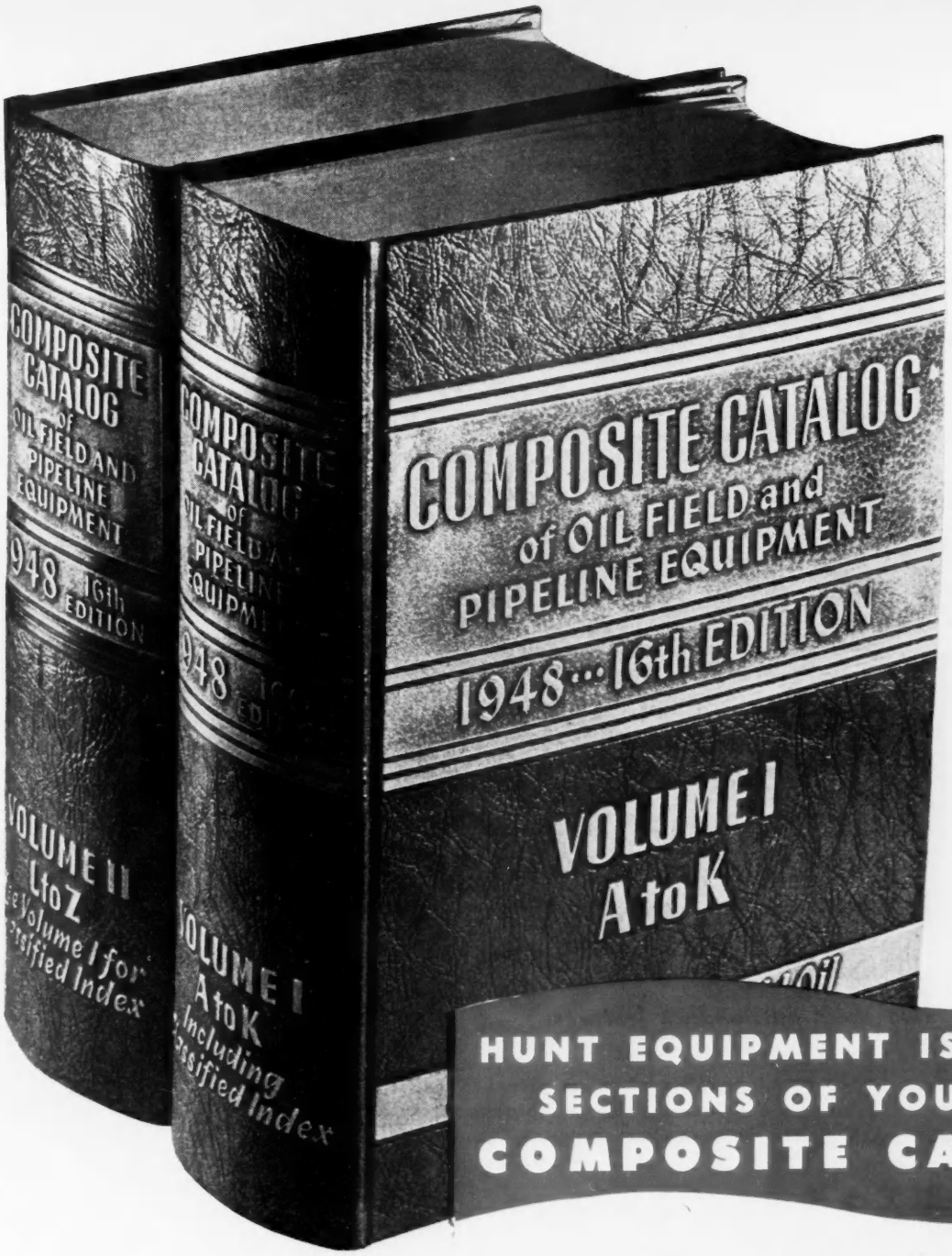
The 1949 model is powered by a 90 horsepower Continental engine driving a fixed pitch wooden propellor. It has a cruising speed of 115 miles per hour, a top speed of 128 miles, and 850 feet per minute rate of climb.

Empire Trust Company Names Rice Assistant Vice President

Charles Leslie Rice, Jr., has been made assistant vice president of Empire Trust Company, New York.

Charles L. Rice, Jr.

Since 1945 Rice has been engaged in the development of the bank's interests in the petroleum industry, which has included the establishment of an advisory service on oil financing and oil investments. He is vice chairman of the Economics Committee, Petroleum Division, American Institute of Mining and Metallurgical Engineers.



HUNT EQUIPMENT IS IN BOTH SECTIONS OF YOUR 1948 COMPOSITE CATALOG

Hunt's regular line of welded-in blade drilling bits, conventional wire line and side wall coring tools, valves and other drilling equipment are shown in Volume 1. The newest addition to the Hunt line . . . Roofe Swivel Joints, Steel Drilling Hose and Steel Cementing Hose . . . is described in Volume 2 under the name Roofe. *Individual copies of these catalogs are available on request.*

HUNT

HUNT TOOL COMPANY

TOOL COMPANY

HOUSTON, TEXAS

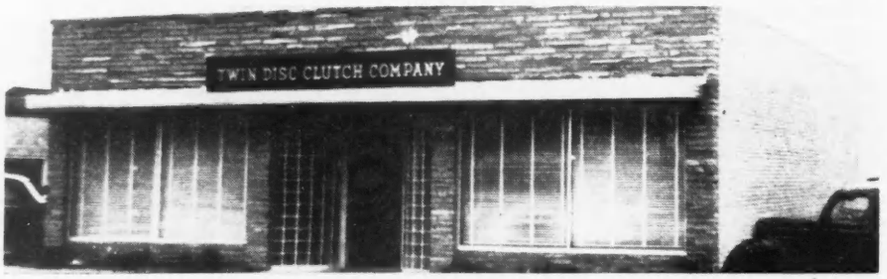
FIELD SHOPS: Houston, Bay City, Corpus Christi, Jennings, Harvey
EXPORT SALES: Hunt Export Company, 19 Rector St. New York; Adva. Pte. R. Saenz Pena 832, Buenos Aires; Port of Spain, Trinidad; Mexico City, D.F.

A BUSINESS BUILT ON *Good* SERVICE

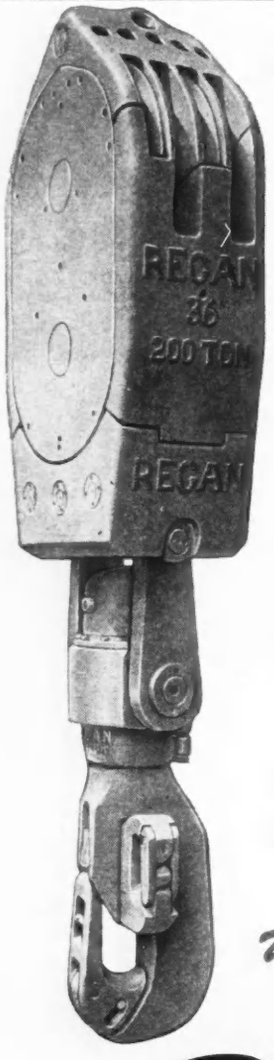
Cameron Iron Works Opens Store To Serve West Texas Division

Roy Davis, West Texas division manager for Cameron Iron Works, was host to approximately 750 oil and supply men at the opening of a new Cameron store at Odessa, Texas.

Cameron officials and employes who attended the celebration were E. L. Lorehn, vice president and general manager; Ralph McCullough, secretary-treasurer; Bob Farmer, assistant sales manager; J. M. (Red) Teague, service manager; Homer Brown and Gene Teer, Houston; and Merle Hooks, Hobbs, N. M.



TWIN DISC MOVES OFFICE—The Tulsa Branch Sales Engineering Office of the Twin Disc Clutch Company has been moved to 2910 East 15th Street from its former location at 310 East Fourth Street. The Tulsa office is in charge of Wade A. Eskridge, assistant district manager, and is headquarters for Oklahoma, Kansas, Missouri and Colorado.



The new look

BY REGAN

Regan is pleased to announce that they now have available their new, compact,

200 TON
COMBINATION TRAVELING BLOCK AND COMBINATION CASING HOOK

Note these outstanding features:

1. Shortest overall working height yet offered to the industry for a 200-ton capacity combination... —135½" from bight of Hook to top of Traveling Block.
2. All forged alloy steel Combination Hook.
3. Uniquely designed so that Hook swings at right angles to Traveling Block sheaves.

Write Now for new special Bulletin giving more complete details of this new outstanding combination.

Regan
Forge & Engineering Co.
Quality — Wrought on the Forge of Experience
SAN PEDRO CALIFORNIA
HOUSTON, TEXAS, U. S. A.

EXCLUSIVE MID-CONTINENT REPRESENTATIVES:
Hunt Tool Company, P. O. Box 1436, Houston, Texas
EXCLUSIVE EXPORT REPRESENTATIVES:
Hunt Export Company, 19 Rector Street, New York City, N. Y.
Avda Pte. R. Saenz, Pena 832, Buenos Aires, Argentina

Young Radiator Company Purchases Atlas Imperial Diesel Engine Firm

The purchase of the Atlas Imperial Diesel Engine Company plant and facilities at Mattoon, Ill., has been announced by F. M. Young, president of Young Radiator Company. Young Radiator manufactures heat transfer products and has plants and offices at Racine, Wis., with sales and engineering offices in principal cities from coast to coast.

Young stated that plans are now being made to build additional facilities at Mattoon to accommodate increased production and expansion of the line of large vertical air discharge cooling and condensing units, jacket water coolers, and other products.

Turner Named Credit Manager For Republic Supply Company

J. W. Turner has been named credit manager for Republic Supply Company, Houston. Turner has moved to Houston headquarters from Corpus Christi, where he was associated with the Sam E. Wilson Interests.

J. W. Turner

He is a graduate of Oklahoma A. & M. and has spent all of his business career in the oil industry. He was employed by Lucey Products Company, Tulsa, in the Treasury department, and served several years in the Credit department of Oil Well Supply Company at Dallas.

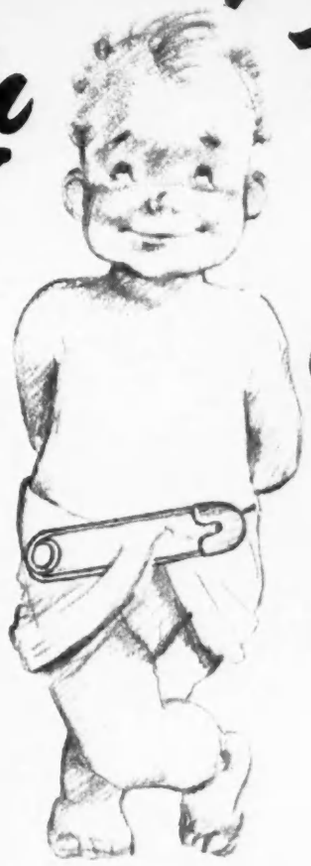
H. A. McDannald will assist Turner as assistant credit manager.

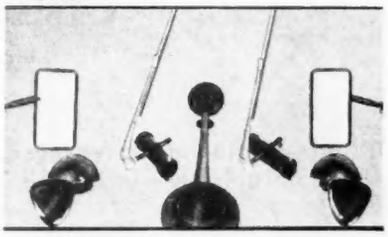
Steel Improvement & Forge Company Appoints Houston Representative

Harry N. Dunn Company has been appointed Houston representative of The Steel Improvement & Forge Company, Cleveland, which produces a wide range of forgings, in stainless steel, copper base alloys, monel metal, as well as carbon steels.

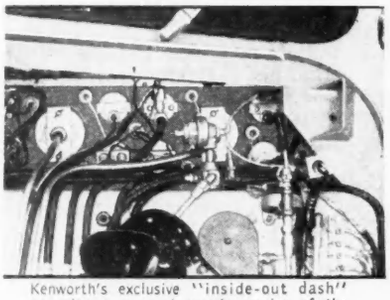
Offices of the Harry M. Dunn Company are located in the M & M Building, Houston.

What A Big Difference A Pin Makes...





Supplying of dual equipment is standard production procedure with Kenworth.



Kenworth's exclusive "inside-out dash" permits easy and speedy service of the instrument panel.

Complete illustrated parts and service manuals are provided all Kenworth truck owners.

Kenworth's continuous full length cab door hinges withstand heavy duty service.

Often much depends upon a pin—and this applies especially to the spring pin in a heavy duty truck. That's why Kenworth trucks come equipped with front spring pins and bushings of threaded steel. This type of pin and bushing greatly increases the area of bearing over the conventional pin and bronze bushing. They form their own labyrinth grease seal, effecting a considerable saving in lubricant. The superiority of Kenworth front springs is widely acknowledged. They have double wrapped eyes and are 4 inches wide and 48 inches long—materially increasing the safety and smooth riding qualities of Kenworth trucks. The fact that replacement of front spring pins on Kenworth trucks due to wear is practically unknown is one more of a long list of reasons why *there's more WORTH in* **KENWORTH.**

KENWORTH

TRUCKS BUSES

FACTORY AND HOME OFFICE: SEATTLE
DISTRIBUTORS IN PRINCIPAL WESTERN CITIES AND HAWAII

Directors Name Carl Brockway Vice President of Thermoid Company

Carl Brockway has been elected a vice president of Thermoid Company. Prior to his becoming associated with Thermoid in 1941, he was president and general manager of Worldbestos Corporation, a brake lining manufacturing concern. In his new capacity, Brockway will be responsible for production of brake linings, clutch facings and other friction materials for Thermoid.

Before entering the friction materials industry he gained a wide manufacturing experience in the automotive industry. Starting in 1907 with the Willys-Overland Corporation as factory superintendent, he held executive positions with the old Interstate Automobile Company at Muncie, Ind., the Splitdorf Corporation, and Industrial Research Corporation.

O. J. Fister Appointed Assistant To Vice President of Oilwell

O. J. Fister has been appointed assistant to L. H. Keim, vice president of Oil Well Supply Company, with headquarters at Oil City, Penn.

Fister has been with U. S. Steel since 1935, starting with Federal Shipbuilding and Dry Dock Company at Kearny, N. J. He has been assistant manager of industrial relations at Federal since 1943.

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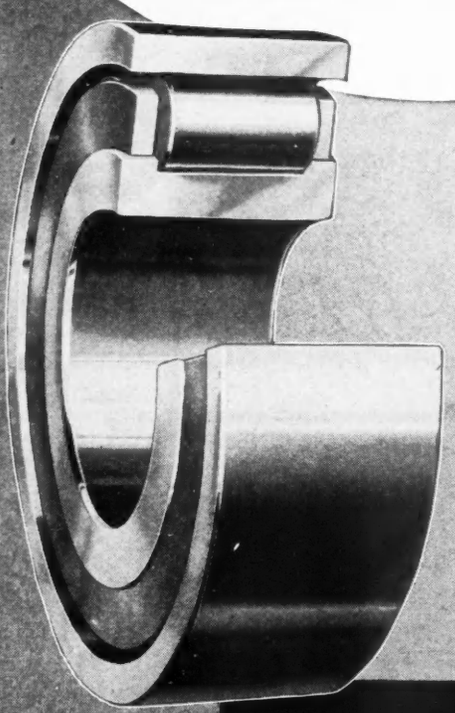

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420 Melwood Street Pittsburgh, Pa.

Pacific Coast Office:
1718 S. Flower St., Los Angeles, Calif.

Shaffer Tool Names O'Connor As Export Sales Representative

D. T. O'Connor has been appointed export sales representative in New York for the Shaffer Tool Works of Brea, Calif., succeeding E. L. Carter. O'Connor has had 18 years experience in foreign fields on production and drilling jobs and has spent three years as owner and operator of a field machine shop in Rodessa, La.

D. T. O'Connor

J. P. Killingsworth Named Manager Of Bovaird Supply Store in Duncan

The Bovaird Supply Company has opened an oil well supply store at Duncan, Okla., with J. P. Killingsworth as manager. He was transferred from Seminole, Okla., where he has been a Bovaird salesman. Field men are James Kiker and Melvin M. Brooks. V. P. (Pat) MacAnally is the district manager of the Oklahoma City territory.

In the past two years Bovaird has opened new stores at Odessa, Texas, and Pauls Valley, Okla., and an office at Dallas. The addition of the Duncan store brings the total of Bovaird offices and stores to 18.

Edwin L. Fetzer Joins Staff Of Southern Geophysical Company

Edwin L. Fetzer has joined the staff of Southern Geophysical Company in Fort Worth with offices in the Sinclair Building. Fetzer was formerly with National Geophysical Company in Dallas for 11 years. He will supervise the work of several seismograph crews of Southern Geophysical Company in West Texas.

Edwin L. Fetzer

Bell Receives 35-Year Service Award From Goodyear Tire & Rubber Division

William T. Bell, manager of distributors' sales and a charter member of Goodyear Tire & Rubber Company's mechanical goods division, recently completed 35 years of service with the company. He received his service award from E. J. Thomas, Goodyear president.

Bell joined Goodyear in 1913 and after helping to set up Goodyear's Akron office, he was made office manager of the Chicago district, which then extended to the West Coast. In 1919 he returned to Akron as sales manager of hose and railroad rubber products, advancing to his present post in 1939. He is still in charge of railroad sales also.

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IN YOUR NEW COMPOSITE CATALOG:
GEYSER "PERFECT CIRCLE" CEMENTING SHOES
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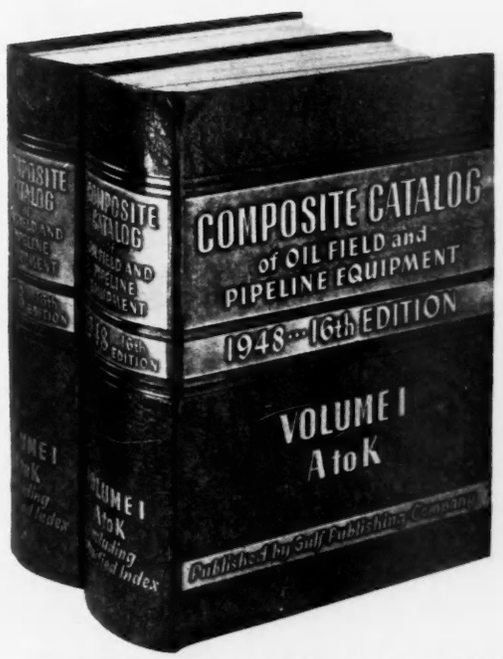
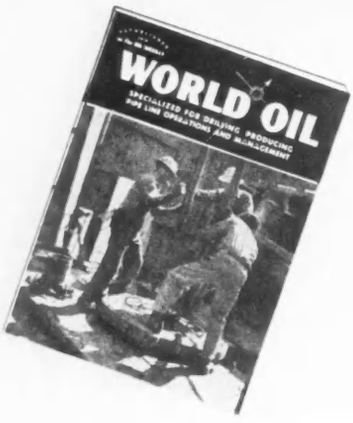
CASING CENTRALIZERS
TUBING HEADS
CASING HEADS . . . TUBING HANGERS
CASING SPIDERS . . . CASING CLAMPS
SWAGE NIPPLES . . . BULL PLUGS
PACKERS . . . SAND PUMPS





for the

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☐ Producing Company ☐ Manufacturing
☐ Pipe Line ☐ Supply

EQUIPMENT and SERVICE SUPPLIERS' NOTES

J. T. Lewis Appointed Oklahoma District Manager for Kobe, Inc.

J. T. Lewis has been made manager of the Oklahoma district for Kobe, Inc., succeeding John J. Prichard, who previously was named division field engineer of the Mid-Continent Technical Service section.

J. T. Lewis

Lewis has been a member of the Kobe organization since 1942, starting in the shop at Oklahoma City. He was transferred to the Technical Service Department as junior engineer and then to sales. He was promoted to Kansas district manager in 1946.

U. S. Rubber Names Chief Engineer Of Wire and Cable Department

Howard H. Weber has been appointed chief engineer of wire and cable department of United States Rubber Company and A. S. Basil general sales manager. Basil has been associated with the company since 1926 and Weber since 1934. Both men have had wide experience in electrical sales and engineering.

Other appointments announced by C. W. Higbee, manager of the department, are H. J. MacDonald, assistant to the manager; H. F. Johnson, assistant general sales manager; R. A. Walker, merchandise manager; J. A. Leuver, assistant sales manager in charge of distribution; D. B. Karlskind, assistant sales manager in charge of commodities, sales engineering and new projects; G. E. Hubrig, sales manager, Western division; C. A. Bartron, chief sales engineer; A. E. Aune, manager, automotive and aircraft wire sales; and R. C. Cassidy, manager, Uskon sales.

D. C. Ogden Named Office Manager For Oilfield Machine and Supply

D. C. (Dave) Ogden, formerly with Boosh-Ross Company in Houston, has joined Oilfield Machine and Supply Company as office manager.

D. C. Ogden

Ogden handled inside sales in his former job and has moved into the same position with OMSCO. He has been associated with oil field equipment companies for more than 14 years.

Jewett Joins National Tank Company

L. M. Jewett, formerly with Schoenfield, Hunter and Kitch at Oklahoma City, is now with National Tank Company at Hobbs, N. M.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Two Vice Presidents Elected By Continental Supply Firm

D. D. Dellinger, treasurer of The Continental Supply Company since 1940, has been elected vice president in charge of finance. He will also continue serving as treasurer.

D. D. Dellinger

Noble A. Endicott, sales manager for the past six years, has been named vice president in charge of Gulf Coast operations with headquarters at Houston.

Jack A. Mussler, since 1939 manager of tubular division, has been appointed general manager of sales, a newly created position.

Dellinger poined Continental in 1933 as assistant treasurer and served in that capacity until his elevation to treasurer in 1940. Endicott entered the services of Continental in 1916 and Mussler became associated with Continental in 1935.

Sheffield Steel Corporation Names San Antonio District Manager

George P. McCracken has been appointed district manager of the San Antonio office for Sheffield Steel Corporation, succeeding George P. Lacy, who has been promoted to manager of railroad sales, with headquarters at Kansas City, Mo. McCracken has served as district sales representative under Lacy for the past three years.

Walter H. Leo has been appointed district manager of the Dallas office. He has been associated with Sheffield nearly seven year in various capacities and has recently served in the St. Louis office.

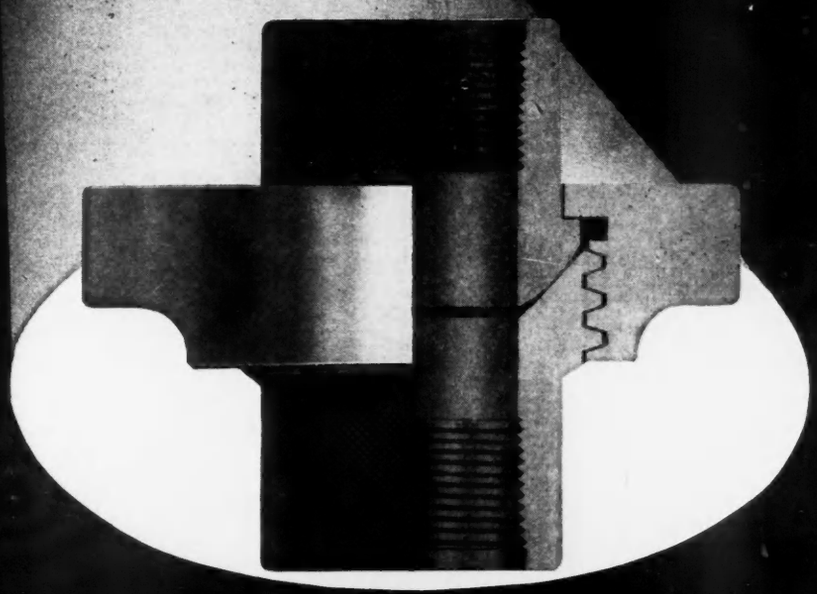
Stewart & Stevenson Appoints Laredo District Representative

A. B. (Dick) Grant has repoined Stewart & Stevenson Services, Inc., as representative for the Laredo, Texas, district.

A. B. Grant

A veteran of four years in the Army as transport officer in the India-Burma theater, Grant has been associated with diesel gas engines for more than 14 years. He spent several years in the Orient before the war as export representative for various manufacturers. As Laredo representative for Stewart & Stevenson, he will have charge of sales and service on GM Diesel engines and Continental Red Seal gas engines for the northern section of Mexico and the Wintergarden section of the Rio Grande Valley of Texas.

FIELD FAVORITE FOR 5 REASONS



1 MAXIMUM SIMPLICITY . . . there are just three parts to WECO Unions with complete interchangeability of all similar parts within the same size and pressure rating.

2 MAXIMUM STRENGTH . . . Stronger, thicker walls on forged steel sub ends of WECO Unions resist distortion and prevent failures even after repeated use. More actual steel by weight.

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Jobber to carry small inventory for local oil fields. Proven necessity to meet emergency in oil drilling, repeat business. Articles appeared in Oil World and Diesel Progress. Excellent possibilities. Box 56W, c/o World Oil, Houston, Texas.

Well established, expanding seismograph company offers openings for thoroughly experienced central office interpreters, field party chiefs, observers and surveyors. Good salaries and opportunity for advancement. Please state in first letter type of position wanted, education, age, experience, salary expected and date available. Address: Box 60W, c/o World Oil, Houston, Texas.

WANTED: Seismologists for division office of major oil company. Men with considerable experience as party chiefs preferred. These positions very attractive for men with families who want to settle in permanent locations. Give full details of education and experience in first letter. All replies will be held confidential. Address: Box 51W, c/o World Oil, Houston, Texas.

PRODUCTION HOIST SALESMAN—We have excellent opening for man in sales of production hoists in Mid-Continent area. Engineering education with field experience desirable. Confidential. P. O. Box 2092, Houston, Texas.

SITUATIONS WANTED

Experienced material man and field equipment. Warehousing, inventories, audits. Field offices, including engineering accounting. Thoroughly trained 20 years major oil companies. Drilling and production. College education. Sober. Go any place. Address 62W, c/o World Oil, Houston, Texas.

Exceptionally experienced man in drilling, pipeline and all phases of production. Oil field construction and planning. Over twenty years experience with major oil company. Further details if wanted. Address: Box 61W, c/o World Oil, Houston, Texas.

GEOLOGIST desires change. Has M.S. in geology; one year on geophysical crew; 5 years in army; two years working Gulf Coast subsurface with major oil company. Address: Box 57W, c/o World Oil, Houston, Texas.

MANUFACTURERS REPRESENTATIVE OR SALES AGENCY connection wanted. Do you need to have your Company and Products actively represented by a Graduate Engineer who is a Houston Resident widely acquainted with the Oil, Gas and Chemical Industries of the Southwest? If so, write Box 59W, c/o World Oil, Houston, Texas.

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Rotary drilling rig complete.
Cardwell Drawworks.
International and Waukashaw motors.
Gardner-Denver pump.
4½" drill pipe.
Oil well bath rotary table.
1600 gallon butane tank.
96 foot mast and all equipment complete necessary for drilling operation.
Now operating in western Kentucky. Priced to sell. Contact Ashby Bros. Drilling Co. 1906 St. Clair Avenue, East St. Louis, Illinois.

FOR SALE

No. 10 Unit Rig Draw Works, Twin D 13000 Caterpillar Diesel Engines, now working.
Kiowa Drilling Company, Inc., 717 Union National Bank Bldg. Wichita 2, Kansas. Phone 3-8013.

For Offshore Operations

FOUR (4) L.S.T.'s

For immediate conversion to purchasers requirements and specifications.

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For Sale: Oil Field Machine Shop—One of the fastest growing towns in Kansas—Best Oil play in state. Write to box 317, Plainville, Kansas or phone 301.

FOR SALE

IDEAL-AJAX—12x12 Twin Steam Drilling Engine horizontal fully enclosed roller bearing heavy duty.
EQUIPMENT — Automotive relief valves attached to cylinders. Ajax throttle valve, mechanical lubricator, steam separator and trap, bleeder valves. Approximately 20 ft. API-4 rotary chain practically new. Extra 19 tooth sprocket. Engine just completed 11,000' well. PRICE "as is" $900.00. Located at Humble, Texas. C. J. ROBERTSON, SR., 1546 Mellie Esperson Bldg., Houston, Texas. Phone: Ch. 4-4743.

1 No. 45 Fort Worth Spudder, complete with tools to drill 4500 foot well. Condition of rig and tools A-1. For complete inventory of this equipment, write Joseph J. Snyder, 503 Oak Street, Carmi, Illinois.

FOR SALE

SURPLUS POWER UNITS

38—LEROI D-382 oil base, 4 cylinder engines, 4½"x6" bore & stroke, 57 HP at 1200 RPM. Complete with TWIN DISC clutch, steel skid, starter generator, safety switches. Immediate delivery. $885.00 each. F.O.B. Rockdale, Texas.

Also NEW LEROI D-176 engines @ $450.00; 5, 10, 25 KW generators; Byron Jackson PUP, Hale Fire, Carter, Gould, Lombard, Barnes, centrifugal pumps w/engines. NEW, export crated w/spare parts & tools. Tank trailers; CRANE & WHEATLEY Valves; Hobart welders 300 amp.: H. H. COFFIELD, c/o W. H. ORR, ROCKDALE, TEXAS.

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PIPE GRINDING MACHINE designed and built to give pipe line contractors maximum service in polishing the bevel on plain end pipe in preparation for welding. The machine can be placed on pipe easily and quickly, and will clean the bevel on 24-inch pipe in 15 seconds, whereas a man with file would have to work at least 15 minutes. The grinder is constructed for durability, light weight, effectiveness and economy. Electrically driven, it may be operated from electric welding machines on the line.

The Machine was perfected, and now being manufactured by

WICHITA TOOL REPAIR CO.
of Wichita Falls, Texas
Under license from O. R. Hall, inventor.

FOR SALE—7,000' Complete Rotary Rig 94' Moore Jackknife Mast—2 Buda 1879 Diesel Engines—20½" Emsco Rotary—G-500 Emsco Drawworks—6¾"x14" GD Slush Pump—4,000' good drill pipe. This rig now drilling in Barton County, Kansas. All equipment in A-1 condition. No commission paid. Subject to prior sale. MALLARD DRILLING COMPANY, 1016 Union National Bldg., Wichita, Kansas.

For Sale: 49-C Star Spudder with 165 HP motor (gas or gasoline) in good shape for drilling to 5000 ft. Tools, equipment and 3500 ft. drilling line. Location Southern Oklahoma, near Durant.

Write Box 1098, Shawnee, Okla.